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THE REPORTED ELECTRIC EQUIPMENT of the Great Northern Railway, on its Cascade division, is officially denied by Third Vice-President James N. Hill, in response to a query from this office. Mr. Hill says that the company does not contemplate, at the present time, the operation of any part of its railway by electricity.

THE DREDGING OF MANILA HARBOR is to be performed by the Puget Sound Bridge & Dredging Co., of Seattle, Wash., of which Mr. C. E. Fowler, M. Am. Soc. C. E., is President and Chief Engineer. The contract just awarded to this company by the government contemplates the dredging of the harbor and the completion of the Spanish breakwater, and the estimated cost of the work is about $2,000,000.

A FRANCHISE FOR SURFACE RAILWAYS in St. Petersburg, Russia, has been secured by Murry A. Verner and H. Sellars McKee, of Pittsburg, Pa., from the St. Petersburg City Council, says the Pittsburg "Times," and the ordinance is now in the hands of the Minister of the Interior. The franchise covers all the surface traction of the city and proposes electricity as the power, horse cars alone being now used. The length of the present system is about 85 miles, while the population of St. Petersburg is put down at 1,267,000. Plants to provide the cars and the electrical appliances may be established in Russia, though nothing is definitely known as to future plans.

THE GROWTH OF AMERICAN EXPORTS of railway materials to Spain is noted in the British "Board of Trade Journal," for Sept. 19, 1901. The La Robla Railway, which had previously used only English and Belgian engines, in 1898 bought six new engines from the Baldwin Works, after investigating purchase in England, Belgium, Germany and France; and in April, 1900, eight more engines were ordered from the Baldwin firm. The Santandar Railway, in October, 1900, wanted 102 cars and 4 engines; the English manufacturers offered them in 20 months, while the Baldwin's offered to deliver in 7 months, and received the contract. The Durango Railway, which formerly used English and Belgian rolling stock and rails, has ordered 40 cars, 6 engines and 23,000 tons of steel rails from the United States. The Northern Railway has ordered the bodies of 600 freight cars from America, because they could be delivered in 4 months instead of 12 months, as demanded by English makers. The Ontoned Railway has ordered two American engines, because they were cheaper and the date of delivery was earlier than in the case of the English offers.

AN EXAMPLE OF RAPID TUNNEL WORK is recorded in connection with the construction of the new plant of the Lackawanna Iron & Steel Co., at Stony Point, near Buffalo, N. Y. The actual work on the shafts was commenced on May 1; on May 20 it had been carried to a depth of 35 ft. in the east shaft, and on May 26 the west shaft had reached a depth of 37 ft. This depth was through soft material and it was necessary to use a 10 × 10-in. timber lining closely placed. At the depths given rock was reached and blasting was commenced, although the compressor had not arrived. Both shafts were sunk 15 ft. by hand labor; on June 1, air was started through a 3-in. pipe, and on July 20 both shafts were finished, the east one being carried down 60 ft. below the cribbing, and the west one 54 ft. The tunnel was started and carried 387½ ft., making a total distance of 500 ft., driven in 48 days. After finishing the rock work the tunnel was lined with brick and concrete between the brick wall and the rock. The shafts were treated in the same way. Throughout the work the hoisting was done with Mundy hoists and stiff-leg derricks. With the exception of two light injuries on the hands, nobody was hurt. The superintendent of the drilling and other work was Mr. James Judge. The contractors for the tunnel work were Conrad Schroeder and Edmund A. Bartl. Two Ingersoll-Sergeant drills were used in each heading and air was supplied by an Ingersoll-Sergeant compressor.

A DIAMOND DRILL BORING 4,800 FT. DEEP has been put down by Mr. Edward Chester, of the Chester Drilling Co., on the Turf Club Ground at Johannesburg, South Africa. A special Sullivan drill was used, made by the Sullivan Machinery Co., of Chicago, Ill. The hole was started in January, 1899, but was stopped in October owing to the Boer War, and work was resumed on June 14, 1901; exclusive of the stoppage by the war the hole was drilled in 10½ months. As the rods weighed about 16 tons; to prevent this weight from pressing too heavily upon the carbons while drilling, the rods were suspended from a hydraulic cylinder in such manner as to permit any desired pressure upon the drill head. This hole was put down to test the position of the Rand reef, and this formation was struck within 25 ft. of the estimated depth. The deepest holes previously sunk in the Rand are the Rand Victoria bore hole, 2,400 ft. deep, and the Bezuidenville hole of 1895, 3,251 ft. deep.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision of freight trains on the Chicago Great Western Ry., near Lombard, Ill., Oct. 10. Four of the train crew were killed and three injured. Two unknown men who were stealing a ride are said to be missing. The cause of the wreck is not known definitely, but it is supposed that one train ran by the station without properly reading the signal. This is the fourth accident within two weeks occurring in spite of signals or protecting devices.——In the case of the accident near Utica on the 8th, noted in our last issue, the engineer of the wrecked train is said to have run past both distant and home signals set against him. In the wreck at Hummelstown, Pa., on Oct. 5, fog obscured a signal, and the train went through a derailing switch provided to protect temporary single track movement over a bridge. In a rear-end collision near Onward, Ind., on Oct. 6, the engineer of the third section, on account of fog, could not see the lamp signals given him to protect the preceding section, which had become stalled.

THE COLLAPSE OF A VAULT ROOF of large dimensions occurred at Boston, Mass., on Oct. 7, 1901. The vault was being constructed as an addition to the Boston City Hall, to be used for storing the records of the City Auditor. The structure was trapezoidal in plan, the lengths of the two longer sides being 39½ ft. and 40¼ ft., and those of the two shorter sides being 26¼ ft. and 26.45 ft. One side wall of the vault was formed by the foundation wall of the City Hall and the other three sides were solid concrete walls about 2 ft. thick. The roof was carried by the side walls and an I-beam extending lengthwise of the vault at the center. This I-beam was 12 ins. deep and was in three sections. At the junction of these sections there were two columns extending down to a steel plate bearing on the concrete floor of the vault. The I-beams were connected to the tops of the columns with one bolt in each flange. The roof consisted of two very flat arches, sprung from the lower flanges of the I-beam at one end and at the other ends from a skewback consisting of a 2 × 2-in. angle built into the concrete side wall at the outer side of the vault and into the foundation wall of the City Hall on the inner side of the vault. The arches were very flat, the rise being about 5 or 6 ins. The steel members of the arches were 9-in. channels curved to the curve of the arch and laid flat, with the flanges upward. On and imbedding these channels was a concrete and expanded metal arch 4 ins. thick; the concrete being composed of one part Atlas Portland cement, two parts sand and five parts cinders. No tie rods were used to equilibrate the thrust of the arches. At the time of the accident the roof had been completed about ten days and about 2 ft. of loam had been deposited on its top as a portion of the covering, the vault being underground. The failure occurred a few hours after the removal of the centers upon which the arches had been built. The cause assigned for the accident is that the centers were removed too soon.

THE NEW CINCINNATI WATER-WORKS COMMISsioners, in their controversy with Mr. A. J. Henkel, contractor for the new settling reservoirs, have been sustained by the report of an engineering commission appointed to investigate the contention. This board was made up of Major W. H. Bixby, Engineer Corps, U. S. A.; Mr. Alfred Noble, of the Isthmian Canal Commission, and Mr. H. A. Carson, Chief Engineer Boston Transit Commission, all Members of the American Society of Civil Engineers. The contention of the contractor was that the 4-in. test borings shown bidders did not properly indicate the character of material to be found, and thus misled him in his bid, and he stopped work. The engineers found, by 4-ft. test wells sunk to include the borings, that the agreement of these borings with the material found is good for the class of materials concerned; that the outcroppings are sufficient to indicate to a bidder the character of rock, and that the material encountered in the excavation is not materially different from what a prudent bidder would have considered possible or probable. Mr. Henkel, however, claims that certain statements made by the experts warrant his claim for extra compensation on account of scattered limestone encountered in the excavation. He offers to leave the amount of extra compensation to arbitration, if an agreement cannot be reached otherwise. He also lays down other conditions to be agreed to before he resumes work. Among the latter are the permission to "use conglomerate for concrete revetment and roadways" and payment for all such material above 40,000 cu. yds. that is encountered and not used.

THE WATER-WORKS CONTROVERSY AT AUSTIN, Tex., in progress since the city built works, in 1891-5, bids fair to be settled by the sale to the city of the competing works owned by the Austin Water, Light & Power Co. It is reported that the city and the company have come to an agreement by which the city will pay the company $175,000, in seven equal yearly installments, in addition to such judgments, if any, as the company secures in the court for back hydrant rental. Later reports state that the city council voted to purchase the plant by a vote of 8 to 6, but that a temporary injunction against the purchase has been secured by taxpayers.

OVER 40,000 PREMISES IN PHILADELPHIA contain water fixtures for which no permit has ever been issued and for which no water rental is paid. According to the local papers, Chief Inspector Harshow summarizes the report of the recent inspection as follows:

Number of properties inspected, 248,236; number of properties in which were found fixtures for which no permit had been issued, 40,418; approximate additional revenue due the city, $156,057. The city has lost a very large amount of money from the fact that fixtures were placed in houses by plumbers without notification and without permits, so that in this way many property owners avoided the payment of additional charges for water used. The gross amount of the additional revenue represents the interest on a capitalization exceeding $4,000,000, so that the reinspection has enriched the city, practically, to that extent.

The last general inspection, it is said, was made 16 years ago. No wonder Philadelphia consumed and wasted 220 gallons of water per capita in 1900!

THE NATIONAL RIVERS & HARBORS CONGRESS, held at Baltimore, Oct. 8 and 9, was attended by about 150 delegates, representing some 20 states. Mr. Geo. E. Bartol, of the Philadelphia Bourse, was chosen President and Col. W. H. Love, of Baltimore, Secretary. Resolutions were adopted calling on Congress to make liberal appropriations for river and harbor work, indorsing the system of continuing contracts, favoring the construction of an isthmian canal and condemning the insertion of appropriations for other than navigation improvements in river and harbor bills. Among the speakers before the convention were Messrs. L. Y. Schermerhorn and L. M. Haupt, of Philadelphia, and Mr. J. A. Ockerson, of St. Louis.

A NAVIGABLE DEPTH IN THE SEA OF AZOV is to be obtained in a somewhat novel manner. This almost land-locked basin connects with the Black Sea by the Strait of Kertch, a strait about 2 miles wide, with a maximum depth of water of 27 ft. The available depth of water at the ports lying on the sea of Azov varies from 5 to 14 ft., and all lading of freight requires the use of lighters, making an appreciable extra charge especially on grain, the great staple export. All attempts on the part of the government to maintain channels of sufficient depth to accommodate sea-going vessels have failed. It is now proposed to close the Strait of Kertch by a dam, providing locks in the channel, and thus raise the water sufficiently to give an available depth of 20 ft. at all ports on the Sea of Azov. The work would include, besides the dam across the strait, a low dam or dike on the peninsula of Taman, about 8 miles in length and 7 ft. in height, and the protection of a large amount of shore property, as well as compensation for damages to existing harbor works, etc. The extra charge on cargoes would be cut down to about one-sixth of its present amount.

THE HAMILTON-FOSTER SYSTEM OF FOG SIGNALing, now in use on Falkner Island, Long Island Sound, gives the exact direction of the sound by an arrangement of eight 5-ft. megaphones. This apparatus automatically revolves toward each point of the compass in turn, and gives a signal for each point by a simple code of long and short blasts. Any passing vessel must hear one of these sounds more clearly than the others; and the signal which it hears most distinctly tells the exact direction from which the sound comes. The apparatus can be placed upon moving vessels, and used to avoid collision in a fog. This signal is to be placed at other points on our coast, and the Canadian government is constructing one at Fame Point, on the Gulf of St. Lawrence.

METHODS OF CONSTRUCTION OF THE NEW CAMBRIDGE BRIDGE SUBSTRUCTURE, BOSTON, MASS.

By Sanford E. Thompson, Assoc. M. Am. Soc. C. E.*

Last year saw the final completion of a new steel bridge upon masonry piers to connect Boston with Charlestown, Mass., and at the present time there is under construction a tunnel under the harbor between Boston and East Boston, and also a new bridge to replace one of the old wooden structures over the Charles River between Boston and Cambridge.

FIG. 1. VIEW SHOWING PILE-DRIVING IN PROGRESS FOR PIERS OF NEW CAMBRIDGE BRIDGE, BOSTON, MASS.

The New Cambridge Bridge will be nearly half a mile long, and it will have a width of 105 ft. for trolley cars and highway travel. The superstructure is to be of steel. The ten piers supporting the trusses are now in process of construction under a contract amounting to over half a million dollars with Holbrook, Cabot & Daly, of Boston. The construction has not proceeded far enough to warrant a description of the engineering features of the design, but the plant used by the contractors is of such magnitude, and the methods employed by them, while comparatively simple, are so economical as to merit description.

Like most of the engineering structures in the vicinity of Boston, the piers of the new bridge rest upon timber piles. Concrete enclosed by a temporary cofferdam, which will be described later on, is laid upon these piles, and above this concrete foundation the piers are built of granite ashlar with a concrete core. The features of special interest as the work is now progressing are: The pile driving; the cutting off of the piles; the construction of the cofferdams; and the concrete mixing and laying, and these will be taken up and described in order.

Fig. 1 is from a photograph taken in December, 1900, and shows the pile driving in progress. In the center is the steam pile driver, and just behind it to the left can be seen a portion of the cutting-off saw. The pile driver for driving the sheeting is further to the right. Fig. 2 was taken in January of this year from about the center of the temporary wooden highway bridge for use during construction and looking toward the Cambridge shore. On the right is shown one of the first cofferdams and the steam pile driver, the pile driver for driving the sheeting, and the cutting-off saw; the latter is located at the extreme right of the view. Fig. 3 was photographed more recently from about the same location on the temporary bridge. In this view will be seen at the left the concrete mixer with the dredge used for hoisting the gravel, while at the right of the picture is the cutting-off saw and the machinery for depositing the concrete in the pier.

PILE DRIVING.

Some 15,000 piles will be used in the ten piers. These piles are brought from Maine on vessels, and unloaded into the river. The pile driver which rises out of the water about 75 ft. was designed and built by the contractors. The general construction of the pile driver is similar in outward appearance to those ordinarily used for such work, but in place of a cast-iron hammer the gin is fitted with a Warrington steam pile hammer manufactured by the Vulcan Iron Works of Chicago. As shown in Fig. 4, the hammer consists of a heavy ram on the end of a piston rod which runs up through the frame into the steam cylinder. To operate, the hammer is raised in the leaders by an engine located upon the scow; the pile which is to be driven is then hoisted and placed in position, and the hammer allowed to rest with its full weight upon the pile, thus causing it to settle through the water and mud; steam is then turned on and the hammer pounds automatically until the pile is driven to the required depth. The weight of the hammer is about 9,800 lbs., while the striking parts weigh about 5,000 lbs. It is a "gravity" machine, that is, the steam lifts the piston and is suddenly released, allowing the weight to fall by gravity onto the pile.

The required steam pressure is 90 to [illegible] lbs., and the hammer is capable of giving from 60 to 70 blows per minute. In order to drive the piles below the surface of the water a follower of white oak 14 ins. square and from 25 to 35 ft. long is used. This follower is capped at each end with cast iron. The hammer with its follower is clearly shown in Fig. 1.

The contractors, Holbrook, Cabot & Daly, probably hold the "record" on pile driving. Their average day's work, when running steadily, is considerably over 100 piles driven in ten hours, while they have driven on a single day of nine hours 212 piles. On a day when the writer visited the work the number driven was about 150. The piles then were about 40 ft. long, and the heads after being driven were 18 ft. under low water. The material penetrated was a hard clay.

CUTTING OFF HEADS OF PILES.

Floating in the water is another machine similar in general appearance to a pile driver, but if observed closely it will be seen that in place of a hammer there is a vertical revolving shaft attached by bearings to a vertical timber or spud. Since the piles have to be cut off from 15 to 34 ft. below water level, the machinery for doing the work has to be unusually heavy and durable. The saw, like the pile driver, was designed and built by the contractors.

As has been stated, the machine is like a pile driver in general appearance. The gin is about 60 ft. high and rests upon a scow, which also contains a 40-HP. engine, with a boiler of even larger capacity. This engine, which makes about 150 revolutions per minute, is connected with a horizontal jack-shaft by means of a link belt. The jack-shaft is fixed in position and provided at the end with a beveled gear, which transmits the power to a short vertical shaft also resting upon the scow. This vertical shaft is in turn belted with an open horizontal rubber belt to the saw-shaft. The saw-shaft is about 60 ft. long and 4 ins. in diameter, being hollow. It is supported by three pillow block bearings bolted to the spud, which is a stick of timber 14 ins. square and 60 ft. in length. As the piles have to be cut off at different levels below the surface of the water it is necessary that the shaft with its spud—the relation of these two is fixed—should be easily raised and lowered. To provide for this the driven pulley is not fixed to the shaft, but runs upon a spline or key, that is, the position of the pulley is fixed, while the shaft may run up and down through it. The shaft and spud are raised and lowered either by a hoisting engine on the scow or else by a hand crab at the foot of the gin. To alter the depth of the saw in the water slightly, the latter is used, this being operated by two men, and the rope from it passing up to a pair of blocks at the top of the gin. Keyed to the lower end of the shaft is the circular saw, which is 42 ins. diameter, and runs at the speed of from 400 to 500 revolutions per minute.

The number of piles which this machine can saw off is astonishing. The usual rate when at work is 600 or 800 10-in. spruce piles per day of ten hours, while the maximum number for half a day is 600. In order to saw the piles off at the proper

FIG. 2. VIEW SHOWING CONSTRUCTION OF COFFERDAM FOR PIER OF NEW CAMBRIDGE BRIDGE, BOSTON, MASS.

FIG. 3. VIEW SHOWING CONCRETE MIXER AND GRAVEL DREDGE FOR WORK ON PIERS OF NEW CAMBRIDGE BRIDGE, BOSTON, MASS.

*Newton Highlands, Mass.

grades the spud has painted upon it at certain heights black cross-lines upon white grounds. A horizontal sight is fixed upon some piles already driven, located between the saw and the temporary road bridge, and a man stands on this bridge and by means of a horizontal sight on the bridge ranges by eye the proper line on the spud, the latter being raised or lowered according as the tide is falling or coming in.

COFFERDAMS.

In order to hold the concrete in place as it is laid, and also to permit the water to be pumped out after most of the concrete has been deposited, so that the lower courses of stone can be set, each pier is enclosed by a temporary cofferdam. Since the concrete is laid under water no bracing is required inside of these dams until after most of the concrete is in place and it is desired to start the pumps.

A very good view of a cofferdam under construction is shown in Fig. 2 at the right. A row of round piles about 10 ft. apart are driven by the steam pile driver around the outside of the dam location, and these are braced by shorter piles running out from them diagonally. The principal piles are next capped with a heavy timber, and three wales consisting of 6 × 12-in. southern pine are bolted on the inside. The sheeting is driven by a land pile driver which is set, as shown in Fig. 2, on top of temporary cross timbers resting on the caps of the round piles. The sheeting consists of southern pine 6 ins. thick and of widths varying from 8 ins. to 18 ins. The edges are grooved for heavy splines 1½ × 3 ins. The method of driving sheeting is similar to that followed in trench work on land. A corner piece is first made and placed, then a piece of sheeting is driven 20 ft. away and bolted to the walings, the space between the two then filled, the last piece being driven tight, as a wedge to close up all the joints. The length of the sheeting is 40 ft. Material dredged from the river bottom is dumped outside of the sheeting, and bracing is placed inside when so much of the concrete has been laid that it is necessary to pump out the coffer and start the stonework. This bracing is shown in Fig. 5, which is a view looking down into the interior of the cofferdam after the concrete foundation is complete. The concrete bottom where the men are standing is considerably below the surface of the river. The temporary road bridge with an electric car upon it appears in the picture in the distance.

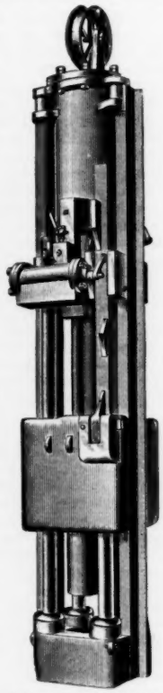

Fig. 4. Warrington Steam Pile Driver for Piers of New Cambridge Bridge, Boston, Mass.

CONCRETE MIXING AND LAYING.

As soon as the sheet piling of the cofferdam is in place, the pier is ready to receive the concrete. The concrete mixer is built upon piling located between two of the piers, and as shown in Fig. 3, and more in detail in Fig. 6, it, with its attendant machinery, is quite an elaborate structure. It is more complicated in fact than would be economical for a small mass of concrete, but when one considers that some 57,000 cu. yds. of concrete are to be laid, the value of doing all of the work possible by machinery is seen.

The cement selected by the contractors is Lehigh Portland. So far out of some 30,000 barrels used not a single barrel has failed to come up to the required test. About 4,000 barrels of cement are stored in the shed, which is shown at the left of Fig. 2. At the time this view was taken the mixer had not yet been constructed; it now sets just beyond the end of the shed. Over 100,000 barrels will be used in the work. The cement barrels are conveyed from the shed to the mixer house by means of a horizontal endless chain having attached to it at intervals wooden trucks which run on a track and are just the size to receive a single barrel of cement. As the cement is received from the conveyor the barrels are opened, and at a signal from the men who do the measuring of the concrete materials the cement from three barrels, enough for one batch, is raised by a bucket elevator to the hoppers over the cubical box mixer.

The gravel from which the sand and gravel is obtained is delivered to the screens by the Eastern Dredging Co. under a sub-contract. It is first dredged from the harbor a number of miles from the work in ordinary dumping scows, and conveyed to the river close to the mixer. Here a pocket has been scooped out of the river bottom, and the gravel is dumped into this pocket. The available space between the piers was limited, and the Eastern Dredging Company designed and built a special machine for lifting this gravel into the hopper above the screens. The boom of the dredge is about 75 ft. long and 18 ins. in diameter at the lower end, and the boom, together with the machinery for operating it, are located upon a movable platform or carriage on the deck of the scow, which allows a greater range over which the bucket can get the dumped material from the bottom and still deliver it to the screen, than can be had with a fixed boom. The range of the movable floor, or carriage, is about 25 ft. The bucket is of the "orange peel" type, and is of about 1¼ cu. yds. capacity, although it is impossible in actual operation to scoop up this amount of material at each lift. The dredge runs twelve hours a day, and in that time hoists some 400 cu. yds. of gravel. The crew consists of one man who operates the levers, a fireman and a deck hand.

An interesting point in regard to the dredging of the gravel from the harbor is that when the wind is east they obtain a great deal of sand, and when it is west they usually have an over-supply of the coarse material.

In Fig. 6 the boom of the re-handling dredge, which has just been described, is shown at the left of the picture, the dredge being hidden by the mixing house. In Fig. 3 the dredge itself is shown just to the left of the middle of the picture. In both views the bucket is down out of sight. This dredge takes the gravel from the pocket in the river bed, as described, and raises it to the hopper shown at the left of the mixing house in Fig. 6, whence it falls on to a pair of inclined screens which are about 15 ft. long and hinged at the top so that their slope can be varied. When noticed, the slope was about 12 ins. horizontal to 9 ins. vertical. The angle is determined by the coarseness of the material. The upper coarse screen is made of iron bars about 3 ins. apart, which run lengthwise of the screen. The stone which is too large for the concrete rolls off on one side, as shown by the pile in Fig. 6, and the medium gravel falls through the coarse screen on to a finer one below. This finer screen consists of two sieves. It was found that the gravel striking a sieve which was of small enough mesh to screen out the sand, tore it to pieces very quickly, and for this reason the coarser screen with mesh of no particular size was placed about 12 ins. above it to break the course of the fall. The gravel from both of these lower screens runs together, while the sand which passes through the finer one—the latter is ¾-in. × 1-in. mesh—falls into a bin below.

Two bucket conveyors, the extreme top of which can be seen in Fig. 6, lift the gravel and the sand to separate V-shaped bins at the top of the mixer house. These two elevators, and also the elevator already mentioned which raises the cement, are all run by the same engine, but are arranged with jaw clutches so that any one of them can be thrown out of gear when desired.

From the bins last mentioned the sand and gravel fall into the measuring hoppers. There are six of these located three on a side, thus making two sets of three each. Each of these sets is of sufficient capacity to receive an entire batch of materials; one hopper for three barrels of cement, the second for the proportionate amount of sand, and the third for the gravel. While one set of these hoppers is being filled, the other set is dumping its materials into the mixer. Only two men are required to do this measuring. With this double arrangement of hoppers the mixer never has to wait for a charge. Sliding gates at the bottom of each hopper control the flow into the mixer, the materials falling out by gravity.

The mixer is a cubical box 5 ft. on edge, and is driven by an engine located upon the ground floor. It mixes about 2 cu. yds. of concrete to a batch. When ready for charging it is placed, with the aid of a friction clutch pulley, so that the door in one corner is uppermost. A V-shaped tunnel is slid in over it and the gates in the measuring hoppers are opened, thus allowing the cement, sand and gravel to fall into the mixer. This done, the tunnel is removed, the door is closed, and the cubical box makes some 15 revolutions, when it is ready to dump. As soon as it commences to turn, water is allowed to flow into the interior through the perforated tube which surrounds the shaft, but as this goes in slowly the materials have a chance to mix dry before much of the water comes in contact with them.

The mortar for the stone masonry is mixed in this same machine. This requires a larger number of revolutions than the concrete.

The concrete falls from the mixer into cubical wooden buckets resting upon small flat cars, which are hauled by a cable operated by a hoisting engine over a track upon trestle work which runs on the line of the new bridge over the piers.

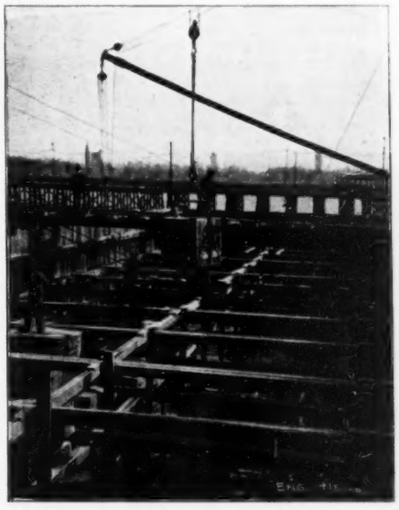

Fig. 5. View Showing Interior of Cofferdam for Piers of New Cambridge Bridge, Boston, Mass.

The method of depositing the concrete under water is illustrated in Fig. 3. The buckets, when they reach the pier where the work is under construction, are taken up by a derrick and conveyed to a movable hopper above the pier. Fig. 3 shows a bucket in the act of dumping. The hopper is built into a platform car which runs on wheels upon the top of a traveler made of two Howe trusses. The latter are connected only at the ends without any inside bracing, and they in turn run upon tracks located on each side of the pier. From this description we see that the platform car with its hopper can be placed at any point within the pier, the motion in one direction being given by the movement of the trusses, and in the other direction by the movement of the platform car itself crossways of the pier upon these trusses.

Of course, from an engineering standpoint it is an impossibility to drop the concrete from a hopper as described directly into the water, since the materials would separate and nothing but the gravel and sand would find its way to the bottom. To prevent this occurrence a tube about 16 ins. in diameter at the top and 22 ins. in diameter at the bottom extends from the hopper down to the level, where the concrete is to be deposited. This tube is built in 4-ft. sections which telescope each other, so that a length anywhere between 40 ft. and 4 ft. may be obtained. The aim is to keep this tube full of concrete all of the time, so that the concrete will flow out of the bottom, instead of dropping out, and form a layer between 1 ft. and

2 ft. in thickness. In order to move the platform car, which contains the hopper with its tube, a lower platform is suspended down between the trusses, and upon this platform are two men who operate the gearing which forces the entire carriage across the pier. The gearing consists of a windlass with a worm gear connecting with a short sprocket chain which runs up to the axle of the wheels supporting the platform car. When it is desired to move the tube lengthwise of the pier, a hoisting engine hauls the truss ahead on its track.

The mixing machinery described has mixed 350 cu. yds. of concrete in one day of ten hours, although an average rate is considerably less than this.

The entire construction work, including the stone masonry, which has not been described in detail, is in charge of Mr. J. W. Rollins, Jr., a member of the contracting firm of Holbrook, Cabot & Daly.

FIG. 6. VIEW SHOWING CONCRETE MIXING PLANT FOR PIERS OF NEW CAMBRIDGE BRIDGE, BOSTON, MASS.

REPORTS PRESENTED AT THE ANNUAL MEETING OF THE ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.

At the annual meeting of the Association of Railway Superintendents of Bridges and Buildings, held at Atlanta, Ga., on Oct. 15, 16 and 17, the following paper and committee reports were presented and discussed:

A COMPRESSED AIR PLANT FOR BRIDGE REPAIR WORK.

By George W. Andrews.*

The use of compressed air in large shops is well known, and having seen its advantages in shop work, and knowing that it had been extensively used in erection, the writer, who had a large amount of bridge work to do (principally strengthening), asked for a plant sufficiently extensive to demonstrate its practical utility. The request was granted, and the result has proven the move a wise one. The plant I describe is one operated by steam, and some will no doubt ask, Why not use a gasoline plant? This, of course, is optional, but the writer prefers the steam, reasons for which it is not necessary to state in this paper.

The plant I have in operation consists of an air compressor, capacity 95 cu. ft. of free air per minute, a 25-HP. boiler, a water tank of 300 gallons capacity, and an air receiver of 150 lbs. capacity. This plant is mounted on a car. When in use the car is placed on a side track as near as possible to the bridge on which the work is to be done; ¾ or 1-in wrought pipes are then connected to the air receiver, or reservoir, and run to the bridge. At intervals along the bridge hose connections and globe valves are placed in the pipe for connections to various tools. The tools ordinarily used consist of drills, riveting hammers and chipping hammers; forges can also be arranged to be operated by the air. In operating, care must be taken to occasionally blow out this pipe to prevent the accumulation of rust or dirt. Good wire-bound rubber hose should be connected to the pipe for tool use, as flexibility is required for moving tools from point to point.

In locating the plant for operation, it is necessary to consider the water supply, as considerable water is needed, not only for the boiler, but for cooling the cylinders of the air compressor. This is just as important where gasoline or gas engines are used. For this purpose I have installed with the plant a small steam pump, which can be set up at the nearest stream, spring or well, and 1-in. pipe run to the car on which the compressor is installed, and by this means an ample water supply can be furnished at small cost. Steam for operating this pump is supplied from the boiler operating the compressor.

Of the tools used there are a number of various manufacture in the market, all of which possess more or less merit. The kind I have in use are as follows: Little Giant air drill press; Boyer short stroke riveting hammer, No. 0; Boyer long stroke riveting hammer (the new long stroke); Boyer chipping hammer, No. 1, and Boyer yoke hammer. For ordinary work I would not recommend the purchase of the latter tool.

In the drill press Morse twist drills are used, the shanks of the various sized drills being made to fit the press. For chipping hammers, cape chisels, etc., bianks are furnished by the manufacturers to be made up into the style necessary, or they can be made in one's own shop. The style of tools necessary will be developed by the class of work to be done As before stated, the plant should be placed as close to the work as possible. This is, however, only as a matter of economy in the running of pipe. I have operated it as far as half a mile from the bridge on which work was done. A plant such as I have described, exclusive of the air pipe for conveying air from plant to bridge, will cost about $1,600.

The cost of operating a plant of this character depends in a great measure on the foreman in charge of the work. The man in charge of the plant should not only see to the proper firing of boiler and running of compressor, but should do the drilling, or assist in same, for all work such as plates, angles, etc., that can be done at car. By doing work of this kind, the actual expense of man for running plant will be reduced at least one half. The amount of coal used will approximate about ¼ tons per day. Ordinary repairs to compressor can be made by the gang in charge. In the 18 months that our machine has been in use the repairs have been very slight, and machine is still in excellent condition. For the drills and riveting hammers the expense is heavier, but as extra valves are supplied, and of which at least two should be carried in stock, there need be no delay in loss of tools while waiting for repairs, as the workman soon become skilled in the handling of the tools, and can make all ordinary repairs, such as replacing valves, etc.

In the use of air drill we find that two men can, under ordinary conditions, drill from five to six holes to one by hand by the same number of men. The drills can be used under ordinary conditions wherever hand drills can be used. In riveting two men will, under ordinary conditions, do the work of three men with hand tools. As is well known by all bridgemen, we use, as a rule, three men besides the heater for riveting, one to hold on, two to drive. With the pneumatic hammer, one to hold on and one to drive is all that is necessary. An additional advantage in this tool is that any intelligent helper can be taught the use of it by a skilled foreman in a day, whereas, under the old hand method, skilled riveters must be employed. Of course, this method, like the hand driving, must be watched to avoid loose rivets. My experience in this has taught that up to ⅞-in. rivets this method is not only effectual, but highly economical.

In the handling of this plant it must not be overlooked that after drilling and riveting on large jobs are completed, there is still another use for the compressor, by having a sand blast machine, of which there are a number in the market, attached to outfit, bridges can be cleaned in not only less time, but much better. Personally, I have not used a machine of this kind, but have seen it used elsewhere, notably on the 155th St. viaduct in New York city. I am now in communication with a manufacturer of sand blast machines with a view of adopting it in manner described.

*Superintendent of Bridges and Buildings, Baltimore & Ohio Ry.

BEST MATERIAL FOR AND COST OF PASSENGER PLATFORMS AT WAY STATIONS.

A circular letter was sent out to the members asking them to state the various kinds of platforms in use on their roads, giving the method of construction, kind of material, cost of platform and average life of the same, with their opinion as to results obtained. Replies were received from 21 members, representing 16 different roads. The replies were from all sections of the country, and probably include all kinds of platforms in general use in the United States. Thinking that the members were familiar with the matter of building platforms, we have tried to give what we thought would be most valuable to them, viz.: the cost of platforms, the length of time they will last, and the satisfaction they give in service. From the replies received we find that there is a great difference in the cost of labor and material in the different sections of the country. The price of lumber runs from $9 to $30 per thousand, with the cost of labor from $1 to $3 per day. With this variation of prices, the cost of a certain kind of platform in one section might be thought too high or low in some other section. Having this in mind in our report, we have given the average cost of each different kind of platform, with the average life and the results obtained from its use. All of the roads report the use of wood platforms costing from6 cts. to 14 cts. per sq. ft., the average being 10 cts. per sq. ft., and the average life 10 years.

Three roads report the use of brick platforms costing from 10 to 25 cts. per sq. ft., with an average cost of 12 cts. per sq. ft. The use of coal tar concrete was reported by four members on two different roads, and cost from 3½ cts. to 14 cts. per sq. ft., with an average cost of 7½ cts. per sq. ft., and an average life of 13 years. Three roads use cement concrete platforms at an average cost of 14 cts. per sq. ft. Nine roads use cinder platforms at a cost of 3 cts. per sq. ft.

It would seem to this committee that for local stations there would be different kinds of platform needed to serve the different kinds of business. At stations where only light baggage was handled and a small number of passengers the use of cinders, crushed stone or gravel might meet all demands. At stations where baggage and express matter are handled in considerable quantities some kind of platform over which heavily loaded trucks can be easily drawn should be provided. Several members criticised the use of cinders and crushed stone, as it is tracked into the coaches and stations, cutting out the floors and making more work to keep them clean. Against this is the less cost of this kind of platform. If cinders are used a suitable curb should be provided to keep them away from the rail. Cases have come under the observation of your committee where cinder platform have been put down, filling level with the top of and against the side of rail, where in a few years the rails and spikes were so badly rusted by the sulphur and acid in the cinders that the track was unsafe for use. Where cinders are carefully rolled and made compact they make a dry platform suitable for light business and at a low cost.

Platforms where trucks are much used should have a hard, smooth surface. For this class of platforms, wood, brick, cement and coal tar concrete can be used, and the kind giving the best results as to cost, desirability and safety would be cheapest. The average cost of wood platforms we find to be 10 cts. per sq. ft., and they last 10 years, making the cost of a wood platform 1 ct. per sq. ft. per year. Brick platforms cost 13 cts. per ft., with no data as to average life. Assuming this to be 12 years (which was named by one member), the annual cost would be a little over 1 ct. per sq. ft. The average cost of cement concrete platforms is given as 14 cts. per ft. and the durability unknown.

The average cost of coal tar concrete is 7½ cts. per ft and average life 13 years, making the cost per year 0.6 ct per sq. ft. The cost of coal tar concrete, as seen from the figures given, is 40% less than either brick or wood. But where this is used some kind of a curbing should be provided. Wood curbing is the cheapest, but will not last. Stone curbing cost about 65 cts. per lin. ft. in position. Cement concrete curb costs 28 cts. per ft., and

should be durable, although your committee could get no information as to its actual life. Taking 10 ft. as the average width of platform, we find that with granite curb the cost of tar concrete platform is the same as brick. With a curbing of cement concrete the cost is 20% less than either brick or wood.

The members using tar concrete platforms report it as very satisfactory, it being hard, smooth and less slippery than any other kind except brick. Its use, however, seems to be confined to a small section of the country; and, so far as we could learn, little was known about it outside of this section. Believing it to be one of the best, cheapest and most economical kinds of material for railway platforms, we will try and give the usual manner of putting it down. First, level the ground, making it about 4 ins. below the desired level of the finished platform. Cover this with a layer 4 ins. thick of broken stone or very coarse gravel or pebbles from ¾ to 3 ins. in diameter, which have been well covered with tar. Roll this down with a stone roller weighing not less than 600 lbs., which has been smeared with crude oil to keep the tar from sticking to the roller. On this bed spread a layer of top dressing prepared in the following manner: Take clean, hard sand, such as would be used for good cement, heat this to about 250° F. and until its moisture has been expelled. Add to this a mixture of three parts of good coal tar and one part coal tar pitch which has been heated until it boils. Stir the sand and coal tar mixture together. When both are hot, spread evenly on the prepared stones about 2 ins. thick. Sprinkle over this fine sand or mica and roll to a hard, smooth surface while it is hot. Tar of good quality, with a heavy body, should be used. Care should be taken in heating the sand, so that it will not be burned. If it does, the concrete will be much injured. When carefully prepared and put down we have seen platforms which have had severe and continuous usage for more than 15 years and are in good condition yet.

J. B. Sheldon, John T. Banks, N. H. LaFontain, L. H. Wheaton, Wm. A. Fort, A. McNab, Committee.

BEST METHOD OF OPERATING TURNTABLES BY POWER.

As the result of inquiries addressed to a large number of railways, the accompanying table has been compiled, showing the general character and cost of operation of a number of power operated turntables:

The general construction of the three kinds of apparatus commonly employed is as follows:

ELECTRIC POWER.—The electric motor through which the power is transmitted is generally mounted on a cast-iron, wrought-iron or steel frame, properly geared to a friction wheel which runs on the circular rail of the turntable; this part of the apparatus is commonly called "donkey." It is attached by a pin joint to one end of the turntable in such a way that the friction wheel runs concentric to the table on the circular rail. The current wires are either brought to the motor by way of an overhead switch or by means of contact rings—one ring fastened to the center bearing, the other to the center cross girders of the table. The donkey and motor are usually covered by a small house for the use of the operator. The current is controlled by a regular street car controller. Generally the power apparatus is provided with an appropriate brake to stop the table at a given point. In some cases sand boxes are provided in the operator's house, to sand the circular rail, to prevent slipping of friction wheel. The electrical driven turntable of the Erie R. R. at Jersey City, N. J., differs from the above described apparatus materially; this table is provided with a regular drum and conical wheels similar to a drawbridge. The power of the motor is applied through a gear working in a circular rack around the drum. This table, we understand, is giving very good satisfaction.

STEAM POWER.—The equipment consists generally of an upright boiler and engine combined, located over the circular rail, and opposite and at right angles to the center of the turntable, resting on a frame connected with arms, extending to the table girders. The movement of the table can be obtained either by means of a friction wheel on the circular rail or by means of a circular rack along the circular rail; the former is no doubt the most economical.

GASOLINE ENGINES.—The general construction of the apparatus is the same as that used on tables driven by electric power, except that, instead of using an electric motor, a gasoline engine is used. The engine is mounted on a wrought-iron or steel triangular frame; this frame is hinged at two points to the girders of the turntable, and supported at one point by a friction wheel on the circular rail. The engine is provided with the necessary friction clutches, speed regulators and foot brake. The whole is housed for the protection of the apparatus as well as the operator. Under the supporting frame a reservoir is provided containing the fuel used by the engine and a silencer to reduce the noise. A water tank is located in one corner of the house.

In the opinion of your committee, no specific apparatus can be recommended for any location of turntable; the kind of power and apparatus required or desirable depends upon the location of the turntable with reference to electric or other power plants. If electric power can readily be obtained from the railroad company's plant or from outside parties, electricity should be employed, as it requires least machinery and is economically maintained; where special engine and electric generator would have to be provided a steam or gasoline apparatus will, no doubt, be more economical and preferable, on account of the first cost of installing the plant, as well as the additional help required to run the engine and generator.

In considering the feasibility of drawing the electric current from an existing railroad plant or a city electric plant, attention should be given as to whether a suitable current is available at all times, including nights and Sundays. In a railroad plant the introduction of the electric turntable device should not be the only cause of requiring help in the engine room and boiler house to be on hand nights and Sundays; in such case it will not prove economical to use electricity. It will also not be desirable to have to run a large central electric machine nights and Sundays on account of the turntables. In other words, there should be a small dynamo at the central plant for use nights, Sundays, holidays and when shops are idle.

The gasoline engine, where electric power cannot be readily obtained except by establishing a special plant, is no doubt the most economical; it consumes fuel only when operated, requires less attention than a steam plant, and is generally more adapted for work of this character. In cities the use of steam power generally necessitates employing a licensed engineer. Further, the supplying of the coal and the removal of ashes all add to the cost and trouble.

The first cost of electric apparatus, 10-HP. motor, controller, donkey, wiring, contact rings, connection of donkey to turntable, operator's house, etc., complete, is about $1,400; the cost of a steam engine and generator will be about $1,700 additional, if a special or additional plant would have to be installed, making the total cost for an electric motor, including engine and generator, $3,100. The first cost of a gasoline engine apparatus complete, including gasoline and water reservoirs and operator's house, is about $1,000. The first cost of a steam engine plant complete is about $1,250.

The cost of operating the various machines per day of 24 hours, based on turning 250 engines, is about as follows:

Electric apparatus, without special engine and generator	$3.92
Electric apparatus with special engine and generator	7.25
Steam engine apparatus	4.40
Gasoline engine apparatus	3.95

The economy of operating turntables by power depends on the weight of and the number of locomotives to be turned in a given time. On railroads where only light locomotives are required to be turned on a certain turntable, the hand power will, no doubt, prove satisfactory and economical. On some of the Eastern railroads locomotives weighing 175 net tons, including tender, are operated; such locomotives cannot, according to actual experience, be turned economically by hand, especially in the winter time.

Your committee is of the opinion that for heavy service turntables some motive power should be applied for their operation. Electric power is recommended where the railroad company have their own power plant in close proximity to the turntable, or when electric power can be purchased from outside parties at a reasonable figure. For points where electric power is not available the gasoline apparatus should be used. Steam power, while satisfactory as to performing the work, is not as economical as either the electric or gasoline apparatus.

F. E. Schall, J. E. Greiner, B. F. Pickering, Onward Bates, Committee.

WATER STATIONS.

As the result of a circular inquiry, this committee obtained descriptions, accompanied by detail drawings, of about a dozen water stations, which it gives in full. The report concludes with the following interesting summary of the committee's special inquiry regarding the use of steel water tanks:

Special efforts have been made by the committee on this subject to get special information in reference to the use of iron for water tanks. Researches were made embracing almost every State in the Union for information in this direction. The information gained has been very favorable, and leads the committee to believe that the time is not far distant when nothing but steel or iron water tanks, and their substructures, will be in general use on the majority of roads. The question is often asked how these tanks can be painted on the inside and at the same time keep them in service. This, we all know, is an impossibility and cannot be accomplished. The use of paint on the inside of a tank, where it is at all times kept filled with water, is useless, and we believe that no good results would follow if it were possible to keep it painted. As an example, we can only refer to the locomotive tanks which are constantly in use and are never painted on the inside. No doubt any of us can call to mind locomotive tanks that have been in service 30 or 40 years and are in a good state of preservation so far as rust from the inside is concerned. Wood for water tanks is short lived. It is true wooden tanks are still standing that were put up in 1880, and are good yet for two or three years, yet, on the other hand, tanks that were put up in 1886 and 1888 must be renewed in the next two or three years. This is attributed to the defective white pine timber that is being used for structures of this kind. While cypress is longer lived than white pine, yet it will be but a short time before this timber will be exhausted and the use of iron will have to be substituted. The committee tried on several occasions to get information in reference to fir timber for this class of work, but no information could be had in that direction. Mr. C. W. Sharpe, Bridge Engineer of the Denver & Rio Grande Railroad, writes that he has no iron water tanks, but has used 16 × 24 redwood tanks, which will last for 20 years, and possibly more. Mr. H. D. Cleveland, Superintendent of Bridges and Buildings of the Pittsburg, Bessemer & Lake Erie R. R. Co., writes as follows:

> I have put up three steel tanks, 21 × 21 ft., and they have been in service three years. I have never experienced any trouble in their freezing up. The only objection I could have to them is the trouble of painting them on the inside, as we have to let them dry before painting, and, of course, after painting we find it hard to throw the tank out of service long enough to do this, and are liable to let it go longer than we ought to. They make a very neat-looking tank with an iron substructure, and I think a very durable tank if they are kept painted.

Mr. James Brady, Superintendent of Bridges and Buildings, Chicago, Rock Island & Pacific Ry., under date of July 26, writes as follows:

> I have two of these tanks on my division, size 20 × 60 ft., capacity 140,000 gallons. I erected both of these with my own men. The cost of labor for erecting was $379.60 each. These tanks are set on concrete foundations. They are located at our large water stations, where there is always a good circulation, and we have no trouble from water freezing in them in the coldest weather. These tanks have been in use for three years, and with the experience I have had with them so far I consider them the best tank. The total cost per tank at time of erection was $2,272.40, but the price of iron was pretty low at that time.

AN ACETYLENE MINING LAMP.

A new type of mining lamp has recently been developed involving the use of acetylene gas obtained from calcium carbide in the well-known manner. In its final commercial form adapted to mining, tunneling and other underground work, the lamp is made in two styles to suit the different requirements for a substantial, reliable working lamp and a smaller hand lamp.

The "Baldwin" Gang lamp is shown below in Fig. 1. A strong cast-iron case made in two parts

TABLE SHOWING GENERAL CHARACTER AND COST OF OPERATION OF A NUMBER OF POWER OPERATED TURNTABLES.

Name of railway.	Kind of power.	Horse-power.	Speed at rim of pit, ft. per min.	No. of engines turned in 24 hrs.	No. of men employed per day 24 hrs.	Diameter of turntable, ft.	Style of center-bearing used.	Power is applied to table by.	Cost of operating turn-table by hand per 24 hrs.	Cost of operating turn-table by power per 24 hrs.
C., M. & St. P.	Electric	10	200	200	2	56	Conical roller	Overhead switch	.....	½ cost by hand.
C. & N. W.	Electric	10	220	100	2	70	Conical roller	Contact ring at center	.....	Less than ½ cost by hand.
C., Bur. & Quincy	Electric	10	300	200	2	60	Conical roller	Overhead switch	$11.25	$4.69
Illinois Central	Electric	7½	207	..	2	66	Pivot bearing	Contact ring at center	16.44	3.00
C. & N. W.	Electric	10	226	400	4	60	conical roller	Contact ring at center	13.40	13.40
L. V. R. R.	Gasoline engine	5	200	144	2	65	Pivot		7.50	3.60
Pennsylvania	Electric	22	370	308	2	75	Conical roller	Contact ring at center	.....	4.34
Pennsylvania	Steam	..	280	..	2	60	Conical roller		.....	4.90
Erie	Electric	15	..	140	2	65	Drawbridge bearing	At center drum	More than double that by power	
Erie	Steam	5	218	124	2	65	Pivot bearing		About twice that by power	4.56
N. Y. C. & H. R.	Gasoline engine	5½	100	150	2	70	Pivot		$6.00	3.66
C. R. R. of N. J.	Electric	10	..	125	4	65	Conical roller	Overhead switch	10.80	4.50
										7.50

connected by clamp bolts contains in its upper half the water reservoir, and in its lower the carbide; a swiveling handle is attached for manipulation. Fig. 2 shows the interior construction. The water reservoir and the carbide tank are clearly seen. A diaphragm is pressed down on the carbide by a spring, preventing all shaking about. The water is fed down through the central tube, the flow being aided by the wire stirrer passing down through. The feeding of the water is by gravity, while regulation is accomplished by the gas pressure holding the water back. Should excessive pressure force some gas out through the water, it will pass off harmlessly through the openings in the top. The acetylene gas generated goes through the passage shown to the burner tube, which is surmounted by a lava tip. A shield around the flame may be raised or lowered as required.

The "Baldwin" Superintendent's lamp, shown above in Fig. 1, is intended for the use of inspectors, surveyors, mine bosses, etc. It is extremely strong, and fitted to be as convenient as possible. The swiveling hook and the double handles enable it to be used in any position, hooked in the coat, held as a bulls-eye, etc. The flame is surrounded by a polished metal reflector. Directly beneath the flame is a metal point enabling the lamp to be

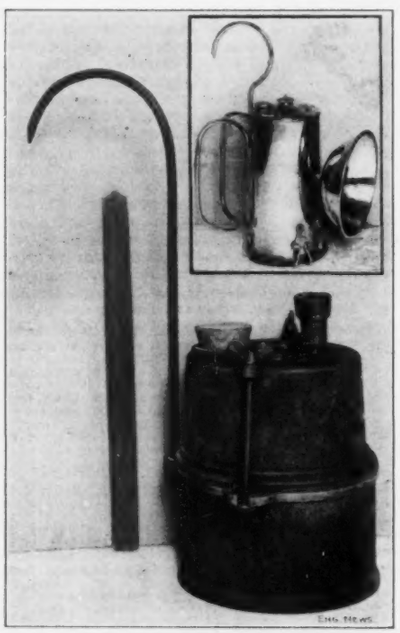

Fig. 1. General View of Baldwin Acetylene Mine Lamps.
The Ingersoll-Sergeant Co., New York City, Sales Agents.

set over a surveyor's point, making an excellent object to sight on. The interior construction differs from that of the Gang lamp chiefly in having a water regulator valve mounted on the feed-stem and controlled by a button on top of the case. The bottom of the case is separate, and carries the carbide cup. This bottom section is held to the body of the case by snap clamps so that it can be attached or detached in a moment, a rubber gasket making the joint gas tight.

The Superintendent's lamp is made in only one size, giving a light about equal to that of an ordinary bicycle lamp. Its capacity is four hours at full brilliancy; the total weight of the lamp is 9 oz. The Gang lamp is made in several sizes, giving from 10 to 20 c. p. for from 8 to 18 hours.

The many advantages of acetylene gas for lighting are now pretty well known, and the Baldwin lamp is the first actual construction utilizing this light that has proved satisfactory for mining use. Heretofore oil has been chiefly used as an illuminant in mining work, except in precious metal mining, where, on account of the undesirable effect of accidentally-spilled oil on the separation processes, paraffine candles have been preferred. In mines using oil, the smoke from the lamps often calls for special attention as regards ventilation, especially in narrow workings or small headings. Paraffine candles, though less troublesome in ventilation, give a poor, variable light at best, and are very expensive, the more so as a great portion of their material is wasted in guttering. Incandescent lighting is an expensive system to instal; the lights and their wiring cannot be quickly moved for a blast; the wires abrade and cut on the rocks, etc. Acetylene contaminates the air less than any other system except incandescent electric lighting. In regard to the carbon dioxide produced, Prof. Vivian B. Lewes gives, for candles, oil, and acetylene gas, respectively, the comparative figures, 43.6, 39.8, 4.0. Furthermore, these acetylene lamps are cheaper than any of the other methods of lighting mentioned. According to a comparative estimate submitted to us, the cost per light for various systems per day of eight hours is about as follows: Candles, 10 cts.; oil, 5 cts.; electric incandescent lamps, 8 to 10 cts.; acetylene lamps, 3 cts. At the same time, acetylene gives by far the most brilliant illumination.

If the first cost be made to enter into the comparison, and we compare acetylene with candles, which require no outlay whatever in first cost, we would get for the total cost of the first year's operation:

Candles for 350 men at $3 per mo. per man	$12,600.00
350 No. 7 Baldwin lamps at $4.50	$1,575.00
175 lbs. carbide per day	3,832.50
Total for acetylene lighting	5,407.50
Saving in favor of acetylene lighting in first year	**$7,192.50**

It may be noted that the lamp is as applicable to tunneling and quarrying as to mining, and may, in fact, be used on night work by contractors, and on railway wrecking work, etc., to replace the ordinary smoky torch. The lamp is being put on the market by the Ingersoll-Sergeant Drill Co., New York office, 26 Cortlandt St., who have kindly furnished the data from which the above description has been compiled.

THE NEW SEWAGE DISPOSAL PLANT AT MADISON, WIS.*

By Prof. F. E. Turneaure, Assoc. Am. Soc. C. E.†

The city of Madison has now been struggling with the problem of sewage disposal for nearly ten years. The natural outlet for the city drainage is into one or the other of the two small lakes which are adjacent to the town, and in the construction of the older sewers these lakes were freely used for sewer out-falls. The lakes are, however, very shallow near the shores, and during the summer are stagnant for many days at a time, so that sewage discharged into them is diffused very slowly and a nuisance is likely to be created. Many complaints of such nuisance along the shores, from time to time, caused the question of purification to be agitated, and after much discussion the city adopted a plan whereby all the sewage would be collected and brought to one point and there treated by a system of combined chemical precipitation and sand filtration. The effluent from such works would be discharged into a small, sluggish watercourse leading from one lake to the other. Under these circumstances it was considered desirable to secure a fairly high degree of purification, although it should be said that neither lake is used as a source of water supply.

Before the above mentioned plan was adopted the feasibility of sand filtration alone had been quite thoroughly discussed and ultimately rejected on account of the high first cost and scarcity of suitable land, although not all those competent to judge were agreed upon this decision.

Shortly after the adoption of the combination plan the American Sanitary Engineering Co., of Detroit, Mich., presented to the city a proposition for the construction of a plant involving the use of ferozone as a chemical precipitant and polarite as a filter, these being patented materials which this company controlled. They offered very high guarantees as to the purification which their scheme would effect and also guarantees as to cost. The proposition was accepted and the company put under bonds to carry out the terms of their contract. The plant was duly constructed and put into operation about June, 1899.‡

It will be unnecessary to enter into a detailed description of these works. It is sufficient to say that they consisted of a series of four chemical precipitation tanks of a combined capacity of about 200,000 gallons, and three polarite filters of a combined area of about 5,500 sq. ft., or about ⅛-acre, designed to filter the effluent from the precipitation tanks. The machinery connected with the plant consists of three gasoline engines of 12 HP. rated capacity each, two centrifugal sewage pumps, a sludge pump, sludge press, chemical mixer, small centrifugal pump for pumping chemical, small rotary pump for pumping water for washing filter beds, and a dynamo. The precipitation tanks and filter beds were constructed by the Sanitary Engineering Co.; the pumps and other machinery were built by the city.

The results of operation which the plant was guaranteed to accomplish were briefly: That the effluent should be as good as would be produced if treated in the way previously adopted; that it should equal in purity the waters of Lake Mendota, as shown by a certain analysis; that the cost of operation should not exceed $3,600 per year for 600,000 gallons of sewage per day, and that the effluent should not contaminate the waters of the lake, and that the plant and effluent in general should be satisfactory. The capacity of the plant was to be 1,200,000 gallons per day.

The failure of the plant to meet the terms of the guarantee is probably well known to most of those present. The chemical tanks did quite satisfactory work, although the amount of chemical required was very high. The filters accomplished relatively little. They clogged up rapidly, and even though cleaned about once in three days, their capacity was not more than 300,000 or 400,000 gallons per day. The cost of operation, including the

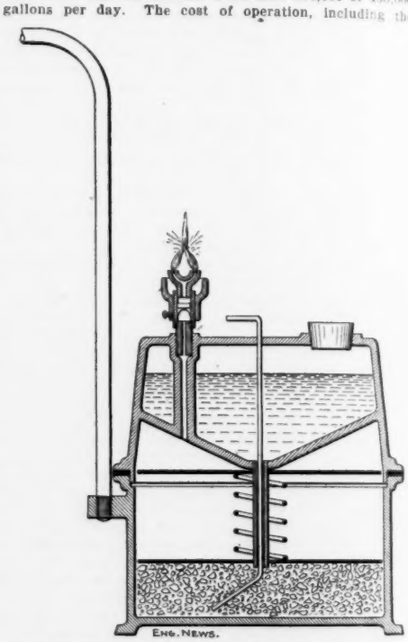

Fig. 2. Section of Baldwin Gang Lamp.

necessary pumping, was at a rate of about $10,000 per year. The plant was not accepted by the city, and litigation is now pending with reference to it.

As the city could not continue to operate this plant, and as the discharge of crude sewage into the lake could not long be permitted, it was necessary to construct a new plant of some sort without delay.

Prof. J. B. Johnson, Dean of the Engineering College of the University of Wisconsin, proposed as the best solution of the problem the construction of a plant involving the use of a septic tank and rapid filter, his opinion being based largely upon the experimental work at Manchester, which had just then been made public. With this opinion the writer fully concurred, and after considerable public discussion he was called upon to recommend detailed plans. In deciding upon the general arrangement it was considered that some kind of filters would be required in addition to the septic tank, but that the purification need not be so great as would be obtained from the ordinary sand filter. The plans therefore contemplated septic tanks and coarse filters. The tanks were authorized first, and construction begun upon them in March last. They were completed and put into operation about Aug. 1. The filters were not authorized until some months later, and construction of this part of the plant is now progressing. It is expected that sufficient filter area will be completed by Nov. 15, so that the dry weather sewage can all be filtered. When this paper was promised to your society it was expected that the entire plant would be in operation by this time, in which case more valuable data could have been presented. It will therefore be necessary to limit the paper to a description of the plant.

*A paper read before the annual convention of the American Society of Municipal Improvements at Niagara Falls, N. Y., Oct. 2, 1901.

†Professor of Bridge and Sanitary Engineering, University of Wisconsin; City Engineer, Madison, Wis.

‡The original plant at Madison and the peculiar contract under which it was built were described in detail in our issue of Dec. 28, 1899; and on Oct. 11, 1900, we published some interesting details, taken from a report by Professor Turneaure, relating to its failure.—Ed.

Madison has a population of about 20,000, about half of which is tributary to the sewers. This proportion is, however, rapidly increasing. About 160 roofs are connected with the sewers, and 340 cistern overflows. The consumption of water is about 45 gallons per capita, and the ordinary dry-weather flow of sewage is about 450,000 gallons per day. In wet weather the flow is increased to about 600,000 or 800,000 gallons, due to inflow of ground water, and after heavy rains the discharge rises to 1,000,000 gallons or more for a short time. As would be expected from the low water consumption, the sewage is of a fairly strong character. The albuminoid ammonia usually ranges from about 0.8 part to nearly 2.0 parts per 100,000, and free ammonia from 1.2 to 3.6 parts. Ordinarily about three-fourths of the albuminoid ammonia is in suspension, a condition which may be considered favorable. The sewage is, however, not readily cleared by sedimentation, owing to the fact that in passing through the pumps the suspended matter is thoroughly stirred up and is left in a state of very fine subdivision.

In fixing upon the design, the matter of economy of construction had to be kept prominently in mind, as the city had already paid out about $25,000 towards a disposal works, in addition to the amount expended for the pumping station.

The pumping station and disposal works are located on low marsh land in the eastern end of the city. The main out-fall sewer carries the entire sewage of the city by gravity to this point, discharging it into a well at a depth of about 15 ft. below the surface. From this well the sewage is raised by centrifugal pumps. In the design of the tanks it was necessary to build them practically on the surface of the ground in order to permit the sewage effluent to pass by gravity onto the filter bed. It was also desirable to have the filter beds as shallow as possible. In fixing upon the capacity of the tank the sewage flow was assumed to be about 600,000 gallons per day and the tank capacity was taken at 400,000 gallons, thus permitting 16 hours' average sedimentation, but nearly 24 hours for the dry weather flow at the present time. A fairly long period of sedimentation was considered desirable on account of the fine character of the suspended matter, but it was thought that larger tanks than the above would offer very little advantage. In the writer's opinion, the danger of septic poisoning of the sewage by a too long period of rest can largely be avoided by the use of long and comparatively narrow settling tanks. It would appear, for example, that a tank might be indefinitely long, provided the velocity of flow is such that the cleared sewage will pass beyond the area of excessive bacterial action in the sludge before objectionable products of decomposition have had time to form. It certainly seems reasonable to suppose that the effluent from an efficient tank might be passed on through a great length of similar tank, or a series of tanks, without detriment. If this theory is correct, the critical point to be determined in a design of long rectangular tanks is the proper velocity of flow, so that the sewage will not remain in the region of excessive bacterial action too long a time. From these considerations it was thought that a long tank was the safer form of construction. The depth of a tank, within quite wide limits, would not seem to be very material, as many experiments on sedimentation have shown that the effect of depth is not great. In this case the depth was determined largely by considerations pertaining to convenience of construction. The tanks as finally constructed consist of two simple rectangular reservoirs, each 30 × 120 ft., inside dimensions. The depth of sewage varies from 6 ft. at the outlet end to 8 ft. at the inlet end. The walls are built of Portland cement concrete, founded on a layer of clean sand about 3 ft. below the surface. They reach to a height of about 9 ft. above the original surface, and are backed by earth embankments which reach within 1 ft. of the top of the walls. The level of the sewage inside is the same as that of the earth embankment. The tanks are covered with an ordinary tar and gravel roof, placed close to the surface of the sewage. Numerous openings, covered by simple board covers, permit access to the tank for cleaning and inspection, and for the adjustment of certain baffle boards used for holding back the surface scum. The floor of the tank consists of 4 ins. of concrete, resting upon compacted clay. Sewage is pumped into the tanks at one end through a cast-iron force main, which is divided into eight branches where it enters the tank at an elevation of 4 ft. below the surface of the sewage. Each branch ends in a bell mouth, where it passes through the concrete wall. By this arrangement the sewage is well distributed along the end of the tank and enters at a low velocity, so that sedimentation can begin promptly. The effluent passes out at the opposite end of the tank over a weir extending the entire width of the tank. To prevent the scum from passing off a number of baffle boards are used, and three of these are placed quite close to the outlet weir. After passing over the weir the sewage flows along a channel in the wall to an outlet pipe, and thence either to the filter beds or directly to the out-fall. Provision is made for cleaning out the accumulated sludge by depressing one end of the tank and providing there a sump connecting with a sludge pipe which leads to the old sludge well at the pumping station. The sludge can then be pressed, or, if desired, pumped into tanks and carted off, all the necessary machinery being already installed. The two tanks are arranged side by side, and both are in continuous operation, the object of making two tanks instead of one being merely to permit of cleaning without interrupting the operation. The contract price for the tank and piping was $7,020. This was higher than it would have been had the contract been let in the summer, as the specifications provided for winter work, involving considerable extra expense.

In the design of the filters there was a choice of many different schemes and combinations. It was at first contemplated to use the ordinary contact beds, with possible double contact. Such an arrangement, however, would have required the construction of water-tight reservoirs, and would have been quite expensive. With further study, it was concluded that the coarse filter operated intermittently, like an ordinary sand filter, would possess considerable advantage; that is to say, a filter in which the sewage is applied intermittently by sprinkling or some like method, and where the pores are never entirely filled with the liquid. Available data, including the results of certain experiments carried out at this place, indicated that such filters would be likely to effect a better nitrification, and, furthermore, they would not need to be water tight nor have any division walls whatever. The only difficulty with this system is in the design of an effective method of distribution. After considering several schemes, the following arrangement was adopted: A bed of an area of one acre was fixed upon as the desirable size. This bed is arranged in two stories, or two beds, each about 2 ft. thick, to be composed of screened locomotive cinders. The lower bed is placed upon a floor of 1-in. boards, laid upon the ground, and having wooden drains constructed therein 16 ft. apart. The boards are used on account of the soft character of the soil on which the filters are built. This bed is composed mainly of cinders from 3-16 to ⅜-in. in diameter. At the bottom is a thin layer of coarser material. The upper bed is supported 12 ins. above the lower bed on a floor of hemlock boards 1 × 4 ins., laid with a ¼-in. space between; 2 × 6-in. joists, resting on 2 × 4-in. posts, support this floor. The upper bed is composed mainly of cinders from ⅜ to 1 in. in diameter. The sewage is distributed over the upper bed by means of 3-in. perforated vitrified pipe, laid 2 ft. apart. The entire bed is rectangular in shape, 140 × 300 ft. in size. There are no division walls or embankments, but exterior embankments of earth and rejected cinders are constructed to retain the filter cinders and furnish room for a drive or footway. The distributing system is divided into seven sections, each covering a space of 140 × 40 ft., and supplied with sewage by an independent pipe. In each section the main distributing pipe runs through the center, and from it branch the lines of 3-in. pipe, each 20 ft. long. These are perforated along the top with 5-16-in. holes, spaced 1 ft. apart, for the escape of sewage. These 3-in. pipes are laid on 2 × 6-in. plank, embedded in the cinders, and are surrounded with cinders up nearly to the holes at the top. The lines of pipe are then covered with 1 × 8-in. boards, placed an inch or so above the pipe. The whole is then covered with fine cinders or other cheap covering to a sufficient depth to prevent freezing. The sewage will escape under a head of from 2 to 6 ins., and by striking against the board covering will be somewhat scattered thereby. Immediately around and under the distributing pipes the cinders will be finer than underneath, in order to aid in distributing the sewage. While this arrangement will not, of course, give a perfect distribution of sewage on the upper bed, it will be fairly good, and it is believed will be all that can be desired on the lower bed. There will also be good aeration between the beds.

The method of operating the distribution system remains to be described. Between the septic tanks and filter beds is placed a receiving chamber of a capacity of about 500 gallons, or about five minutes' flow from the tanks. From these chambers pass the separate pipes to the seven sections of the distributing system, each having a separate valve. Assuming the chamber full, one of the valves is opened and the contents, together with the sewage which enters in the meantime, are discharged quickly and with considerable head upon the one section of the bed. The valve is then closed and the tank allowed to again refill, when another section is dosed, etc. By varying the operation of the valves, the sewage can be applied as often as desired. By this means concentration of discharge is secured, which permits the use of good-sized holes in the distributing pipes, and at the same time gives considerable pressure head, so that small irregularities in construction will not materially affect the distribution. Split pipe, or troughs, would obviously be of no use for distributors in this form of filter. The covering of cinders above the pipe will, it is believed, obviate any trouble from odors due to gases liberated from the sewage as it is applied to the bed. The valves of the distributing pipes will be of the butterfly pattern, and will be operated from the pumphouse by means of wire cables. Automatic operation will be secured by a mechanical device attached to the pumping engines. Provision will be made for flushing the 3-in. distributors by connecting them in groups of seven to a 6-in. cross pipe, provided with a simple wooden gate valve. Ventilators reaching down to the interior air space will be so arranged as to cause some circulation of air in the bed, and manholes placed over the drains will permit of taking samples from any section.

The cost of the filter bed is about $7,500, the city to furnish the cinders f. o. b. at Madison. The estimated capacity is about 1,000,000 gallons per day, or at least 50% more than the present volume.

The tanks have now been in operation about six weeks, and appear to be in good working order. A good scum formed within two weeks. The effluent appears to be of about the same character as the sewage, but with much less suspended matter.

It was expected to present here an analysis of the effluent, but the sampling was postponed until last week, and it then proved to be impossible to get the work done.

Some notes regarding the experiments already referred to, which were made here last winter, may be of interest. These were conducted by university students as a thesis study. A septic tank was used which consisted of an ordinary barrel, into which sewage was introduced at hourly intervals. Two styles of filters were used—a single contact bed operated on the fill-and-draw principle, and a double intermittent filter arranged in the same way as that adopted for the large plant. The cinders used were from ⅛ to ¼-in. in diameter. All filters were 2½ ft. deep, and were operated at a rate of 500,000 gallons per acre per day. The septic tank was started in July, 1900, and the filters in November. Analyses were made at frequent intervals from December, 1900, to April 26, 1901, with the following results for the months of March and April, the last months of the experiments. The average improvement by the septic tank, based on the albuminoid ammonia, was 62%; that by the tank and the upper one of the double filter was 76%, and practically the same by the single contact bed; and by the tank and both of the double filters, a total of 87%. There was practically no nitrification established in the contact bed by the end of the experiment, although in the effluent from the other filters the nitrates reached 0.6 part per 100,000.

The average analysis of the sewage in parts per 100,000 was:

Free ammonia	0.98
Albuminoid ammonia	0.51
Oxygen consumed	14

The effluent from the double filter was very clear and odorless, and would not undergo any putrefaction by standing six weeks in a room at a temperature of 70° F. A bacterial analysis showed that with 5,000,000 bacteria per cu. cm. in the sewage the septic tank effluent had but 3.5% of this number and the filter effluent only 0.6%. The depth of sludge remaining in the septic barrel after ten months of operation was only 1.3 ins. The weight of the solid matter in this was estimated at 0.7 lb., while about 15 lbs. had been delivered to the barrel.

It is thought that the large tanks will do fully as well, being of a better form for sedimentation. Whether we have adopted the very best form for a filter is, of course, an open question. The working of the entire plant will be carefully followed, and in addition it is planned to conduct experiments on several different forms of filters for a number of years, applying to them the effluent from the septic tank. In this way the maximum capacity of the present plant can be experimentally determined without endangering the life of the plant itself, and much valuable data accumulated for use when extensions are needed.

A MUNICIPAL TELEPHONE SYSTEM has just been put in operation in the city of Glasgow, Scotland. The system will provide for 20,000 subscribers, and there are over 16,000 miles of underground wires.

AUSTRALIAN CABLE SOUNDINGS for the new British Pacific submarine cable show 2,800 fathoms, or 16,800 ft., as the deepest sounding off the Australian coast. The line crosses a submarine mountain range, with 257 fathoms on its summit. Anson Bay, six miles from Kingston, has been selected as a cable landing.

THE FROMHOLT DIAMOND ROCK DRILL is described and illustrated in "Le Genie Civil" for Sept. 7. This machine consists of a perforating head armed with black diamonds and rotated by electric power, while the drill is advanced by pressure obtained from a small hydraulic pump operated by hand. The motor is fixed directly upon the drill and runs at a speed of about 1,500 revolutions per minute. Two such drills are attached to a horizontal shaft rotating about a pillar carried by a four-wheeled carriage running upon a one-meter gage track. This drill has been used in driving a 2.5-mile tunnel on the Saint-Andres-des-Alpes Railway, at the Colle Saint Michel. In limestone rock it advanced at the rate of 3.2 ins. per minute; and including the time required for replacing the worn drills, about 30 minutes were consumed in drilling a 5 ft. hole. The inventor expects to reduce the weight so that three or four men can carry the machine and thus do away with the carriage and track. As it could then be set up immediately after firing, a more rapid advance could be made. Nothing is said of the cost of the machine or its maintenance.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

Governor Odell of New York displayed keen wisdom on the long-standing question of what to do with the New York state canals when he told the citizens of Buffalo that they must study the question from a broader standpoint than that of their own private interests. The fact is, as has been plainly pointed out in this journal, that the whole canal agitation in New York has been engineered by a small group of men, most of whom are engaged in handling grain at Buffalo and New York. The Buffalo men want the canal improved just enough to enable them to transfer more grain from lake steamers to canal boats, and will oppose any plan for a canal which will enable boats to pass from the Lakes to New York city without breaking bulk. The New Yorkers, on the other hand, want a canal big enough to bring lake barges to its wharves, and not large enough to let ocean-going tramps go to the Lakes for their lading.

There are, however, indications that the attempt to use the influence of New York's commercial organizations in so narrow a way cannot be successful in the future. Several of these organizations have been for some time associated in the endeavor to have the 1,000-ton barge project adopted by the state. The Maritime Exchange of New York has now withdrawn from this association, and at a special meeting of the Directors of the Exchange on Oct. 14, a motion that the Exchange should favor the construction of a canal for 1,000-ton barges was defeated by a vote of 9 to 3.

Two bridges which have been recently constructed by German engineers, one across the Rhine at Worms, and the other across the Elbe at Harburg, are interesting examples of a principle of construction which, so far as we know, has received practical application in Germany alone. This principle is difficult to define satisfactorily, but it may be partially described, perhaps, by calling it the principle of transverse articulation and freely suspended floor system. In their general appearance the bridges at Worms and Harburg resemble the arch bridges built not so long ago at Bonn and Dusseldorf, as will be seen by comparing the illustrations published elsewhere in this issue with those published in our issue of April 20, 1899. The similarity ceases at this point, however. The curved members in the Bonn and Dusseldorf bridges are two-hinged arches, and were calculated as such, while the curved members in the Worms and Harburg bridges were calculated on the assumption that they were simple braced girders of variable section, with their opposite ends connected by a horizontal chord or tie rod to equilibrate the thrust. So far as the pier reactions are concerned, the structure acts like a simple truss; in fact, in both the Worms and Harburg bridges the ends of the spans are carried on roller bearings, making other than vertical reactions impossible. The salient peculiarity of the two bridges is, however, their transverse articulation and freely-suspended floors. The theory on which this construction was designed is briefly described in the article elsewhere in this issue and need not be repeated here further than to say that the obvious purpose of the design is to effect a reduction in secondary stresses. Admitting that this object is gained, the question which American engineers are certain to ask, is: What practical purpose does this serve? Will there result a reduction in cost through saving of weight or otherwise, or will increased durability be ensured? We cannot see that the design is at all promising in either of these respects. Allowing that there may be some slight saving in material due to a better distribution of the strains, is this not more than counterbalanced by the increased expense of workmanship necessitated by the special details required? European engineers have had much to say in the past in condemnation of what they were pleased to style the loose-jointed construction of the American pin-connected truss, and its consequent liability to be racked to pieces by the impact of heavy loads. No pin-connected bridge ever designed, however, has presented the opportunities for racking, wear and deterioration due to heavy rolling loads and the elements on flexible connections that are presented by these German bridges, with their multiplicity of articulations. Certainly there is nothing in past experience with riveted girders which establishes their liability to premature deterioration due to absence of articulations. On the contrary, such evidence as is available points directly to the opposite conclusion. No form of girder has been found to withstand the test of time so well as the solid plate girder, and next to this in longevity, probably, comes the riveted lattice girder.

But a still more serious question than any we have suggested above will probably occur to American bridge designers. By examining the drawings of the bridges published elsewhere, it will be seen that overhead sway bracing has been entirely omitted, except at the portals. Between these points, for the whole length of the span, there is nothing whatever to hold the trusses square. If this is good bridge design, then American engineers have been mistaken all these years in placing sway bracing between bridge trusses. In fact, according to the German theory, such bracing is not only useless but an injury, since it tends to prevent one truss deflecting more than the other under a load coming on one side of the bridge. If the German theory were a safe guide to practice, it would be comparatively an easy matter to so make the connections of the upper and lower transverse bracing of a pin-connected bridge that the trusses could deflect independently without unduly straining any connection.

Perhaps this is a good way of building a bridge; but we doubt whether any American engineer can be made to think so. To rely on the portal bracing alone to hold erect a pair of trusses 380 ft. long appears a risky procedure, and an American engineer would certainly feel safer after he had placed substantial sway-bracing at every panel point.

The New York Central Railroad Company has prepared plans for the alteration of its Park Ave. tunnel in accordance with the order issued by the New York Board of Health on Aug. 22, and the drawing showing the alteration is printed on another page of this issue. Examination of the drawing will satisfy engineers, we believe, that the proposed change will be a change for the worse and not for the better. No sound and valid engineering reason can be given for tearing out the present substantial masonry arch roof and walls, and building a steel column and girder construction in its place. We called attention in our issue of Sept. 5 to the danger that a derailment may bring down the whole tunnel roof by knocking out the supporting columns. It will be seen that in the adopted construction this has been guarded against to some extent by building a thin low wall between the columns. It is very doubtful, however, whether such a wall would endure enough shock to constitute any real safeguard in case of derailment. The contrast between it and the present massive wall ought to be apparent even to the Board of Health, one would suppose.

Another thing which impresses an engineer is the rapid corrosion which will take place in the steelwork exposed to the corrosive gas of the tunnel. The life of these columns and beams is certain to be very short; and it will be well nigh impossible to determine when the corrosion proceeds so far as to become dangerous. Thus the alteration now proposed will substitute a short-lived construction, requiring constant inspection and possessing inherent elements of danger, for an existing construction which is safe, substantial and permanent.

If there are any compensating advantages to be gained by the alterations, we have failed to discover them. As we said a month ago, the air will be obviously better in the side tunnels and worse in the center tunnel. The larger street openings may slightly help conditions for the tunnel passengers and will undoubtedly increase the smoke, and especially the noise, against which Park Ave. dwellers already protest.

THE BROOKLYN BRIDGE TERMINAL PROBLEM AGAIN.

The report of a board of engineers on the improvement of the Brooklyn Bridge terminal is presented on another page of this issue. Discussing this problem in our issue of April 11, 1901, we said:

> The correct solution is to be found, not in the creation of a vast and elaborate terminal station at great expense, but in the elimination of the terminal to as great an extent as possible.

The plan of relief proposed by Messrs. Boller, Prout and Whinery is framed in entire accord with this principle. Indeed, they themselves enunciate it in the following form:

> To relieve the congestion at the terminal, dependence must be placed, not so much on increasing its capacity as on diverting from it a part of the travel to other stations, thus virtually converting it from a terminal to a way station.

In other words, the best way to improve the present bridge terminal is to abolish it. This is so simple, and yet so vitally important a principle that it is surprising it should so long have been overlooked. Within a half-mile or so of the Brooklyn Bridge terminal, four lines of elevated railway and half a dozen important north and south lines of electric cars have their terminals. Each of these carries an enormous traffic; yet none of them have any extensive terminal facilities or any "terminal problems" to trouble them. The reason is that they all run through and beyond the district where their main traffic is gathered, while the Brooklyn Bridge traffic is all stopped just on the edge of this district, and the traffic which ought to be handled in half a dozen local stations is concentrated in one contracted spot.

When we discussed the Brooklyn Bridge terminal question last April, we suggested relief by an extension of the surface car tracks down Nassau St., through a single-track subway connecting by a loop with a return line on William St., these tracks to be used by a part of the surface

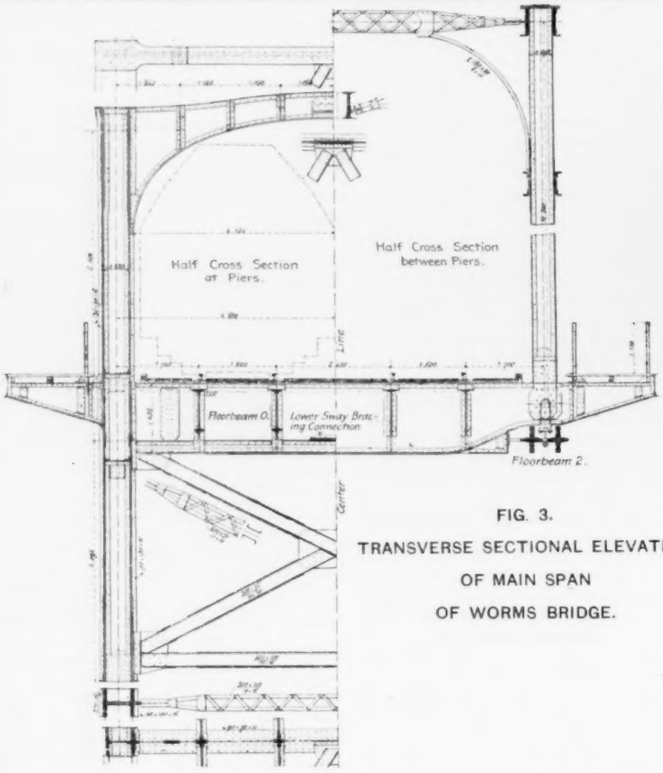


FIG. 3.
TRANSVERSE SECTIONAL ELEVATION
OF MAIN SPAN
OF WORMS BRIDGE.

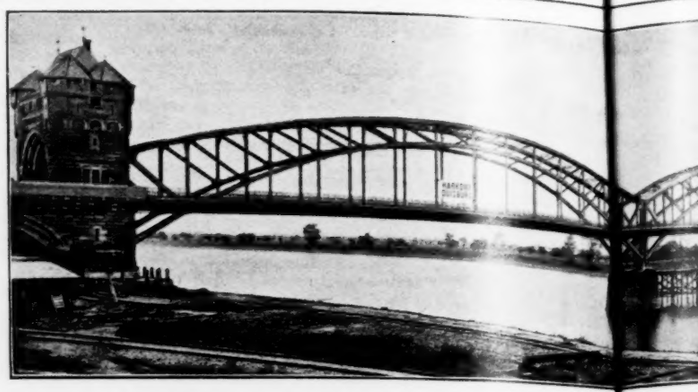


FIG. 1. GENERAL VIEW OF DOUBLE-TRACK RAILWAY BRIDGE ACROSS THE
Harkort Works, Duisburg, Germany, Designers and

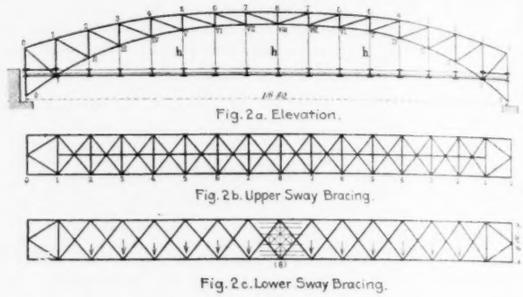
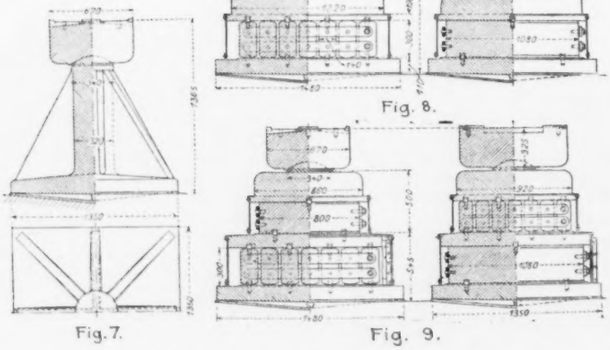


FIG. 2. DIAGRAM PLANS AND ELEVATIONS OF MAIN SPAN
OF WORMS BRIDGE.



FIGS. 7 TO 9. DETAILS OF MOVABLE BEARINGS FOR
MAIN-SPAN TRUSSES AT PIERS, WORMS BRIDGE.

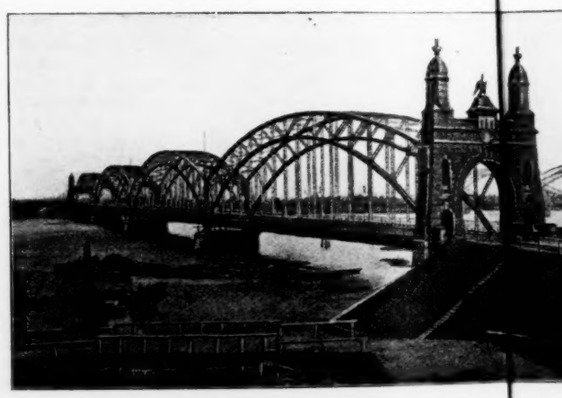


FIG. 12. GENERAL VIEW OF HIGHWAY BRIDGE OVER THE SOUTH ELBE AT
Nuernberger Maschinenbaugesellschaft, Builders

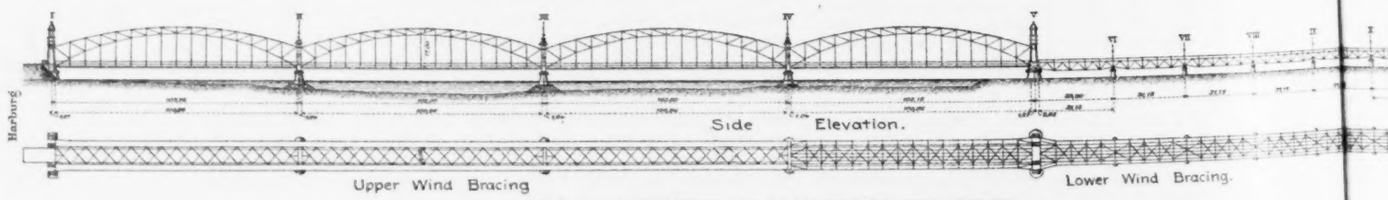
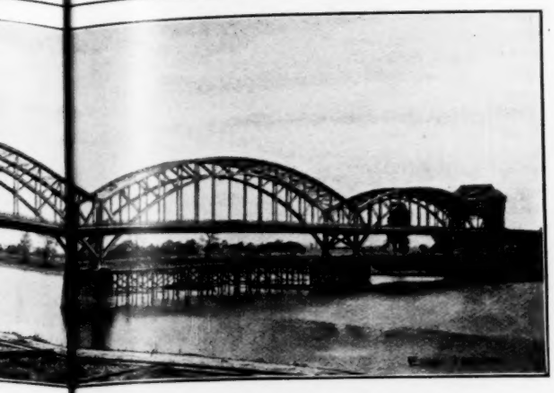


FIG. 11. ELEVATION AND PLAN OF HARBURG BRIDGE.

THE NEW BRIDGES ACROSS THE RHI
ELBE AT HARBURG, G



BRIDGE ACROSS THE RIVER RHINE AT WORMS, GERMANY.
ermany, Designers and Builders.

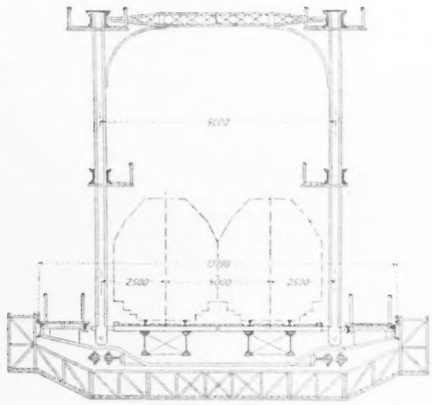


FIG. 4. TRANSVERSE SECTION OF WORMS BRIDGE, SHOWING INSPECTION CARRIAGE.

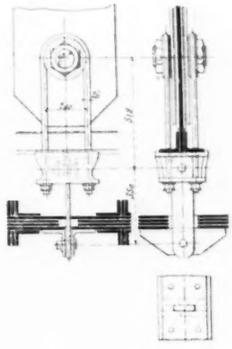


FIG. 5. DETAILS OF SUSPENDER CONNECTIONS TO TIE RODS, WORMS BRIDGE.

Fig. 2d. Fig. 2e.

Fig. 2f. Fig. 2g.

OF MAIN SPAN

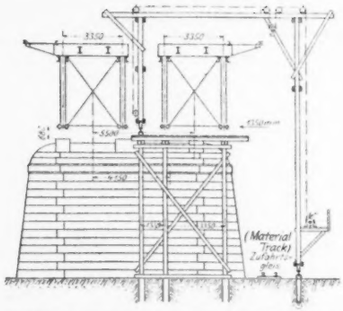


FIG. 10. SKETCH OF TRAVELER AND FALSEWORKS FOR ERECTING VIADUCT APPROACHES, WORMS BRIDGE.

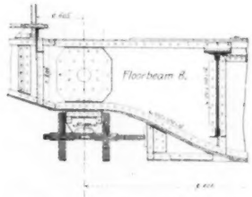
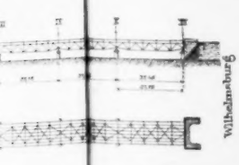


FIG. 6. DETAIL SHOWING RIGID CONNECTION BETWEEN TIE RODS AND FLOOR BEAM AT CENTER. OF MAIN SPAN OF WORMS BRIDGE.

SOUTH ELBE AT HARBURG, GERMANY.
haft, Builders



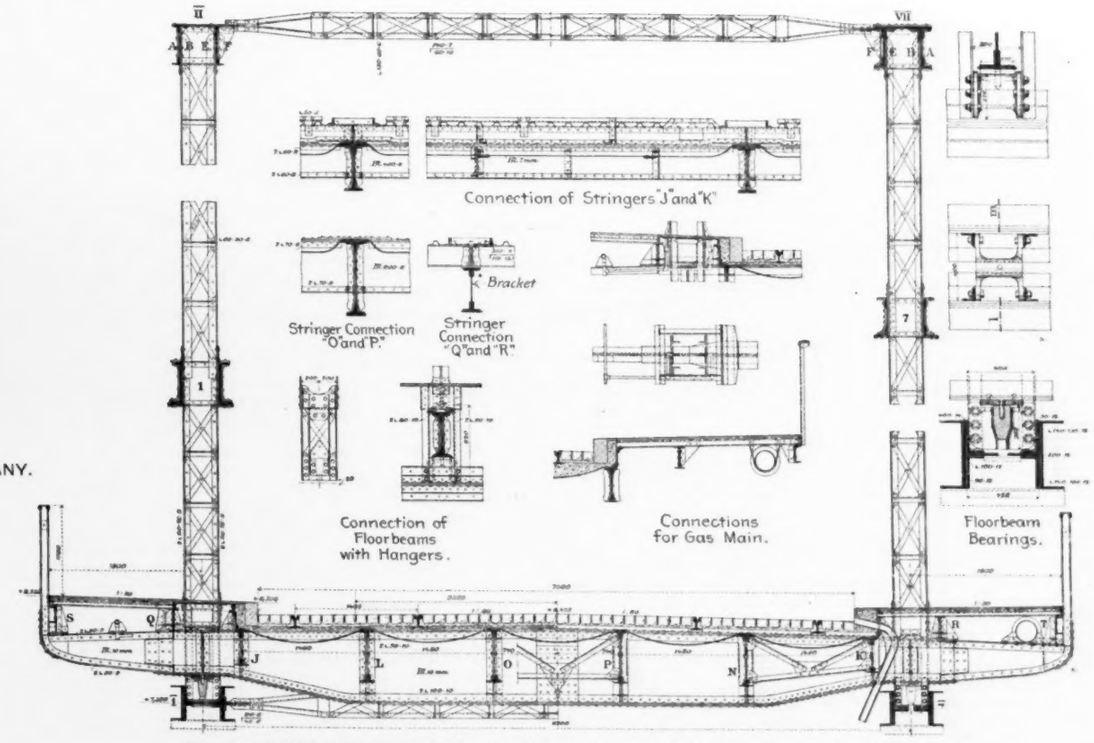

Connection of Stringers "J" and "K"
Bracket
Stringer Connection "O" and "P."
Stringer Connection "Q" and "R"
Connection of Floorbeams with Hangers.
Connections for Gas Main.
Floorbeam Bearings.

FIG. 13. TRANSVERSE SECTION SHOWING STRUCTURAL DETAILS, HARBURG BRIDGE.

OSS THE RHINE AT WORMS AND THE
HARBURG, GERMANY.

cars only, enough to relieve the pressure on the present loop tracks at the bridge. We hesitated to propose a similar radical solution for the elevated tracks on which the bridge trains proper and the through trains from the Brooklyn elevated railways are run, believing that public opinion would roundly condemn any proposal to erect an elevated railway structure on Park Row.

The Board of Engineers, however, have had the courage of their convictions, and have recommended the construction of an elevated railway line down Park Row and Vesey St. to a terminus on the North River, as the only adequate solution of the bridge terminal problem. This recommendation, as might have been expected, has received severe criticism in the newspaper press. We had in mind exactly this public sentiment when we said last April: "An elevated railway down Park Row is hardly to be thought of." Now that it is officially brought forward, we heartily approve it. No other solution of the problem will be so largely to the public benefit. We count it a very fortunate thing that this board of engineers has had the nerve and good judgment to report in favor of the best plan from an engineering point of view, regardless of public opinion. Had they favored some plan for the erection of a huge terminal station occupying a great area of expensive real estate, and costing, all told, two or three times the amount estimated for their present plan, their report would have doubtless received unanimous praise, for the public had been educated to favor some plan of that sort. Yet any such huge station would be a poor and inadequate solution of the problem, no matter what the cost, compared with the simple and common-sense plan which has been recommended.

The crowding of the Brooklyn Bridge terminal facilities has become an old story; and yet it is not generally appreciated how large a problem the handling of traffic over that structure has become. Accurate statistics of the traffic upon it have not been possible since through cars began running across it. On Oct. 31, 1900, however, a count was made of the passengers crossing by bridge and trolley cars, and the total number was 275,823. On this basis the total annual traffic, including foot passengers and those riding in vehicles, is estimated by the board at not less than 100,000,000.* No other bridge or railroad terminal in the world, says the board, handles half as many people daily or yearly as does the Brooklyn Bridge. The number of people handled in 1900 at the Grand Central Station, in 42d St., for example, was about 14,000,000, or less than one-seventh of the traffic handled at the New York terminal station of the Brooklyn Bridge.

Again, not only does the bridge handle the enormous traffic of nearly 300,000 people per day, but this traffic is concentrated in a few rush hours of the morning and evening. Between 7 and 8 a. m., on Oct. 31, 1900, 72,000 people crossed the bridge. To make matters still worse, closely adjacent to the bridge terminal station, and in fact forming an extension of it, is a terminal of the Second and Third Ave. lines of the Manhattan Elevated Ry., with a traffic estimated at not less than 12,000 passengers per hour during the rush hours of the day. Close by, too, is the Chambers St. station of the Rapid Transit road, now under construction, and it is estimated that two years hence this may deliver 20,000 passengers per hour additional at this already overcrowded center. "We may therefore expect," says the board, "that in a very few years, unless some plan is devised for dispersing a part of the travel now using the bridge terminal, not less than 75,000 people per hour must be dealt with in a space not exceeding 200 ft. square."

In view of the figures from an actual count, given above, the board appears to rather understate than overstate the case. The maximum traffic soon to be dealt with in the rush hours at this spot, unless some change is made, would appear to be not less than 100,000. To foster such concentration by further enlargement of the bridge terminal as was proposed by the Chamber of Commerce committee last spring, would be not only foolish but dangerous. We believe it to be imperatively necessary that the contrary course should be taken, and that the Brooklyn Bridge approach should be extended as recommended by the board.

The damage to property-owners along Park Row and Vesey St. by an elevated structure is practically the sole objection raised to the proposed extension in the public press; but this damage ought not to stand in the way of a large public benefit. Park Row is a broad street, in which a two-track elevated structure will cause hardly any obstruction to light and air; and Vesey St. property will, we should judge, receive much greater benefit than injury by the proposed extension.

Space permits only a very brief reference to the other recommendations of the board. We may remark, however, that the loop line on Center St. to connect the three bridges, is the first commendable plan that has been offered for handling the traffic which the two new East River bridges are designed to carry. Unless the city would have more bridge terminal problems on its hands, it must adopt some such treatment as that suggested by the board for the traffic over these bridges.

The weakest part of the board's report, by its own admission, is its decision to keep all the trolley loop tracks of the present bridge within the present terminal structure. As noted above, our suggestion, six months ago, was that the same principle should be applied to the trolley traffic that the board has now adopted for the elevated traffic, viz.: the extension of these tracks further downtown. The board points out, what is undoubtedly true, that there are extreme difficulties in the way of extending these surface car tracks, the traffic on which amounts to some 240 cars per hour in the rush hours, upon or across Park Row. The same objections would not apply to a subway extension, such as we proposed; but we can well understand that the connection between the existing surface tracks and the subway, at the bridge entrance, might involve extreme and perhaps insuperable difficulties. Nothing less than absolute impossibility ought to block this, however, for when the public has once experienced the benefits arising from an extension of the elevated lines, it will insist that the surface lines should also be extended so as to land Brooklyn passengers nearer their final destination.

*It may be of interest to note the enormous growth of traffic on the bridge. From the records published in past volumes of this journal we have compiled the following table, in which the figures after 1886 are approximate only:

Year.	Passengers.	Year.	Passengers.
1883.....	5,440,000	1891.....	39,500,000
1884.....	8,491,000	1892.....	41,000,000
1885.....	17,023,000	1893.....	46,600,000
1886.....	24,029,000	1894.....	41,700,000
1887.....	28,000,000	1895.....	44,500,000
1888.....	30,500,000	1896.....	44,000,000
1889.....	34,000,000	1900 (inc'd'g foot	
1890.....	38,000,000	& vehicle travel)	100,000,000

LETTERS TO THE EDITOR.

Explosions on the Electric Conduit Railways in Washington.

Sir: There have been a great number of explosions upon the electric street cars of this city, generally causing much consternation among passengers and sometimes doing considerable damage.

The cars are propelled by motors taking curren: from an underground conduit. The explosions are sometimes very violent and are accompanied by smoke and flames which often completely fill the car. They seem to take place in the mechanism under the car floors.

Can you explain, through your correspondence column, the cause of these explosions; in what parts of the mechanism they occur; whether made more liable to occur by reason of heavy loads, steep grades or sudden starting; and in what way, if any, they may be prevented? I do not refer to the blowing of fuses or the opening of circuit breakers.

These are points on which I think the general public, in this city at least, would be glad to receive information.

Very truly, Benjamin A. Lewis.

1811 3d St., N. E., Washington, D. C., Aug. 31, 1901.

(For a complete and definite answer to his inquiries our correspondent would doubtless have to refer to the companies operating the electric cars on which the explosions to which he refers occur. He states in his letter that the explosions to which he refers are much more serious than the blowing of fuses; but it may be said that fuses on a heavy electric car sometimes make enough noise and smoke when they go out to cause some alarm to the passengers.

It also sometimes happens on electric conduit roads that a piece of iron, a hoop or wire, for example, is dropped into the conduit by accident or the malicious small boy. It may lie in such a position that it will not connect the opposite conductors until struck by a car plow. The resultant short circuit might then, we should judge, produce some such result as those our correspondent describes.—Ed.)

The Broken Suspender Rods on the Brooklyn Bridge.

Sir: In the engineers' report on the Brooklyn Bridge, published in your issue of last week, the broken suspender rods whose recent fracture caused such alarm are reported "of ample strength to withstand all the forces" to which they are subjected, "and the failure must have been due to other causes."

The "other causes" are not difficult to find, and although they have been already described in the daily press as due "to over-straining," "to vibration," "to extreme heat," etc., I would offer one more suggestion.

The explanation of these fractures will be found in the fact that the suspenders were made of steel, and the screw threads were cut upon them with V-shaped dies. These conditions, with the vibrations or alternate strains described, are sufficient to cause fracture, after prolonged service.

It is a well recognized characteristic of steel that a crack, once started, will creep through the metal—as will a crack in plate glass—by the repetition of slight strains, whether these strains are caused by changes of temperature, by vibration, or by any other influence. The cracks may start from the slightest flaw in the metal, or, as in this instance, from the sharp bottom of V-shaped threads.

To avoid this danger, it is customary in more recent practice either to make such suspenders of fibrous wrought-iron, where the fiber will prevent the crack from creeping, or else, where a stronger metal, as steel, is required, to fillet the bottom of the thread so as to avoid the sharp cut.

The threaded ends of steel pins of railroad bridges have broken off with the nut, apparently without direct strain, under the vibration of passing trains, and the fracture showed rings of rust, indicating that the pin had broken in small increments. The fracture of these suspender rods occurred in the thread in every instance, showed similar rings of rust, and were undoubtedly due to the same cause.

It seems unfortunate, for the information of the public, that the report does not state the yield point, or "elastic limit," and the ultimate strength of the material in each case where it states that the material is overstrained.

Very truly, Henry B. Seaman.

40 Wall St., New York, Oct. 14, 1901.

Concerning the Proposed Increase of Dues in the American Society of Mechanical Engineers.

Sir: I have read your editorial of Oct. 3 relative to the proposed increase in membership dues of the American Society of Mechanical Engineers, and agree with you. It would seem that the proposed expensive investment, which could not be employed at an efficiency higher than 3 or 4%, should certainly not meet with favor among engineers.

The point you make regarding the effect on the membership is, I think, of vital importance, because it is certainly true that the greater volume of the contributions are from members to whom this proposed increase would be a burden.

I hope that this measure will be defeated, because I feel that it would injure the work of the society.

Very truly yours,

A. Bement.

218 La Salle St., Chicago, Ill., Oct. 9, 1901.

Sir: I have just read and have been much interested in the article in your issue of Oct. 3 regarding the pending amendment to the constitution of the American Society of Mechanical Engineers, by which it is proposed to increase the dues of members to $25 a year.

There is no provision for a letter ballot in this society, and such amendments are voted upon only by those attending an annual meeting. Evidently, therefore, by far the larger portion of the membership of the society is deprived of the right of suffrage in this most important particular.

Under such circumstances, open discussion in engineering papers is most valuable. I agree entirely with the writer of the article that "it would be in the highest degree unwise for the mechanical engineers to adopt the proposed increase of dues." The case is practically covered in that part of the article, which will certainly bear repetition, as follows:

Already the dues, we know, are such as to shut out from membership many able engineers, and with the dues raised to $25 per annum this would be much more the case. It is not difficult to find already in the society's membership two classes of members. To one class, hold-

ing high executive positions and in many cases owning large interests in industrial enterprises, the proposed increase of dues is immaterial. To the other class, who are doing the real practical professional work in the field, the shop and the office, the proposed increase of dues is a serious matter. Many such men will, we doubt not, feel obliged to give up their society membership in case the dues are raised as proposed; and the future accessions to membership of just the class of men which the society most needs will be greatly reduced.

Resignations would inevitably result, and, what is much more serious, as you indicate in the last paragraph, many deserving engineers who should by right be members will be prevented by dues which are so abnormally high—so much higher than those of any existing society of engineers.

Such propositions as this inevitably cause engineers who are members of more than one of the societies to sincerely hope that the day may soon come when all the national purely engineering societies will have their headquarters under one roof, even though they may not be consolidated into one great institution of engineers.

Yours respectfully,

Troy, N. Y., Oct. 9, 1901. Palmer C. Ricketts.

Sir: In conjunction, I doubt not, with many of my fellow members, I feel very grateful to Engineering News for the none too caustic arraignment of the management of our society appearing in the issue of Oct. 3. This article is really in the nature of an expose, because had it not been for your paper, in conjunction with the "American Machinist," many, if not most, of our membership (including myself) who were not present at the Milwaukee meeting, and have not carefully scanned the report of proceedings, would not even have heard of the proposed increase in dues, and would have had no chance of expressing our opinion thereon until after it had been actually saddled upon us. As it is, not having been informed officially by the management, we feel it would be somewhat out of place and uncalled for (if not also useless) to write in protest to them; and therefore I hope you will allow me, through the columns of your paper, to signify my *emphatic dissent* from the proposed increase, and thus to call out, if possible, some expression of opinion from the membership at large.

It has long been a marvel to me how smaller and local engineering societies (such as the New York Railroad Club) have been able not simply to maintain a thriving existence, to hold numerous meetings, print their papers and discussion (which in many cases are fully as valuable as ours) and distribute them to the membership, but also to give social entertainments, in return for a membership fee of $2, $3 or $4 per year, while national societies, which number many more members, the bulk of whom are practically no expense to the society except for the annual copy of the transactions, find it apparently so difficult to make both ends meet at a fee per member of $10 to $15 per year. It is, of course, eminently proper that the latter should maintain a somewhat greater pomp and circumstance in accordance with its more august position, but allowing for all this, which should certainly not double the expense, the difference in the expense of maintenance does not seem to be by any means accounted for. Granted that the cost of membership in a national society should be comparatively high for prudential reasons, still there is no reason for lack of care and good management in the funds thus contributed to the society's treasury.

Engineering News is undoubtedly quite right in saying that the Mechanical Engineer's Society calls for greater expenditure and gives less return to its members than any other American or English engineering society, and very likely than any other engineering society in the world. Such wasteful extravagance is in the highest degree to be condemned; and, in fact, which of us does not know of a number of engineers whose qualifications perfectly fit them for membership but who decline to join on the ground that it would be of no advantage to them commensurate with the expense. It is safe to say that had the funds been administered with the same degree of care that characterizes many of the smaller societies, the society would now have enough money in its treasury (with the addition of a mortgage and the sale of its old quarters) to buy new quarters without calling for any additional expenditure or strain upon its resources.

As Engineering News well states, there can be no reasonable doubt that were the proposition of a union engineering building fairly submitted to the membership at large of the several societies the vote would be overwhelmingly in its favor, and it seems therefore a strange anachronism that at the present time in self-governing, independent professional societies such oligarchical rule involving the suppression of that vote should be possible. There would be everything to be gained by such a union—larger quarters for all, more cordiality and harmony in the promotion of common ends, a union library and a greatly increased influence thoughout the country and the world. The motto, "In union there is strength," here applies, and this is particularly true of the last two items.

Unless our society is to degenerate into a mere "millionaire's club," this "folly heaped on absurdity" must be averted. Cannot Engineering News suggest some plan whereby the membership can regain control of the society's management? M. A. S. M. E.

Washington, D. C., Oct. 7, 1901.

Notes and Queries.

The report on 45-ft. rails, presented at the annual meeting of the Roadmasters' & Maintenance-of-Way Association, and published in our issue of Oct. 10, had no signature appended. We have since been informed that the report was prepared by Mr. F. R. Coates, Chief Engineer of the Chicago Great Western Ry.

WIRELESS TELEGRAPHY IN MID-OCEAN was used lately for communicating between the Cunard steamers "Lucania" and "Campania," which met about midway of the Atlantic. Many messages were exchanged at distances ranging from 33 to 65 miles.

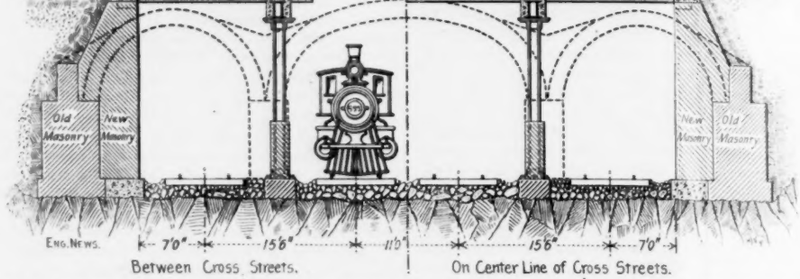


FIG. 1. CROSS-SECTION OF PARK AVE. TUNNEL OF NEW YORK CENTRAL & HUDSON RIVER R. R., NEW YORK CITY, SHOWING PROPOSED ALTERATIONS AS SUBMITTED TO NEW YORK BOARD OF HEALTH.

W. J. Wilgus, M. Am. Soc. C. E., Chief Engineer.

THE WAR ON SMOKE IN ST. LOUIS has assumed active proportions. A paper by Mr. Wm. H. Bryan, read before the Engineers' Club of St. Louis, on Oct. 2, was noted in our last issue. A Citizens' Smoke Abatement Association has been formed for the purpose of aiding in the enforcement of the city ordinances against smoke. The city government has organized a smoke-inspection department, which will carry on its work through a number of inspectors, each covering a specified district. Full co-operation between this department and the Citizens' Association is promised, and are expected to bring about better conditions in regard to smoke in a short time.

PROPOSED ALTERATIONS IN THE PARK AVE. TUNNEL, NEW YORK CITY.

Within the past week, plans have been submitted for approval to the New York Board of Health by the N. Y Central & Hudson River R. R. Co., outlining proposed changes in the Park Ave. tunnel. The essential portion of the plans, a cross-section of the proposed construction, is reproduced here in Fig. 1. The dotted lines represent the existing tunnel construction of stone masonry arranged in a central double-track arch tunnel, and two single-track side tunnels of similar form. It is proposed to remove all masonry except the vertical portions of the outside walls. These will be strengthened by additional masonry to make vertical retaining walls up to the level of the roof of the tunnel. The roof will be formed of concrete carried by I-beams resting at their outer ends upon these retaining walls, and near the line of the present intermediate walls, upon longitudinal girders supported by a line of steel columns with foundations at floor level. The roof beams will be spaced about 3 to 4 ft. on centers, and the columns 17 ft., in the direction of the length of the tunnel. The roof construction will extend a short distance beyond the line of the columns, leaving an open space in the center considerably wider than the openings in the roof of the present tunnel. At cross streets a beam and concrete construction of adequate strength will carry the pavement over the opening. Between the columns in the tunnel a wall of masonry will be carried up to a height of about 6 ft. as a guard to protect the columns in cases of derailment.

The proposal is for the present to reconstruct the tunnel according to this plan for only a comparatively short distance, the ten blocks from 56th to 66th Sts. being had in view for the experiment. Should the construction satisfy all requirements, it would then be carried out on the remaining sections of the tunnel.

The plan is by no means satisfactory to the engineers of the company. The problem is one of long-standing, and has been under consideration for a number of years. The plan, as submitted and as described above, has been brought out only in response to a peremptory order* issued to the company by the Board of Health on Aug. 22 of this year, one section of which requires the immediate removal of the intermediate walls and the substitution of steel columns and girders. A scheme of construction that has been under consideration by the company, and which the latter regards as the best solution of the question, is shown in Fig. 2. Here almost the full width of the tunnel would be opened, leaving only a nominal overhang of 5 ft. on each side. It is considered that with such construction no further complaints as to improper ventilation of the tunnel would be received, but it was feared that objections on the part of Park Ave. residents against it would be too strong.

During the consideration, and more or less public discussion of this problem, the main features of suggestions for improvement have been forced ventilation and electric traction. Broad statements have been made within the last few days in the public press anent the plan for improvement, as submitted to the Board of Health, that electric operation of trains was contemplated for

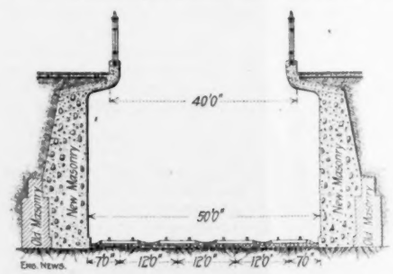


Fig. 2. Alternative Plan for Reconstructing Park Ave. Tunnel, Preferred by the N. Y. C. & H. R. R. Co.

the side tunnels, using these exclusively for the suburban traffic through the tunnel. It was also stated that this foreshadowed the ultimate application of electric traction to all trains using the tunnel. We are informed by an officer of the company, however, that no plans for a change to electric motive power are at present under consideration.

We understand that the railroad company is fully prepared to go ahead with the work of reconstruction on an experimental section, as described above, and is only awaiting the approval

*Eng. News, Sept. 5, 1901; see also editorial comment on this order in the same issue.

of the Board of Health before letting contracts. Details as to the cost of the work are not yet available, but it is stated that bids are at present being obtained. The expense of making the change will, no doubt, be very great, involving the removal of very heavy masonry arch work, and the substitution of the new construction without any interruption of traffic through the tunnel. As about 500 trains pass through the tunnel every twenty-four hours, it will be seen that the work will be by no means a simple or an inexpensive matter.

The matter was brought before the Health Commissioners at their meeting on Wednesday, Oct. 9, Mr. I. E. Place, Ass't Attorney of the New York Central Railroad, representing the company, and will again come up at the next meeting of the board on Wednesday, Oct. 16.

AN EXPERT REPORT ON THE IMPROVEMENT OF THE BROOKLYN BRIDGE TERMINALS.

Following close upon the report of the engineers appointed to investigate the safety of the Brooklyn Bridge, comes the report of a Board of Engineers appointed to devise plans for improving the terminal facilities of that structure, in accordance with the provisions of the "McCarren act," passed at the last session of the New York legislature. As many of our readers will recall, the Brooklyn Bridge terminal problem has been before the public and has constituted a knotty theme for discussion among engineers for nearly 15 years. The growth of the traffic has been such that every improvement in the terminal heretofore made has been at once neutralized—so far as relief from crowding is concerned—by the additional thousands who joined the throng which streams across the great highway every morning and evening.

In March last, the Chamber of Commerce of New York appointed a committee to report upon plans for the relief of existing conditions at the bridge, and the report of this committee (which was substantially that the loop terminal designed by the late A. M. Wellington, M. Am. Soc. C. E., should be adopted) was reviewed in our issue of April 11.

Following this came legislation, as above noted, providing that the Commissioner of Bridges might submit the problem to a board of expert engineers, and in accordance therewith, the Commissioner, Hon. John L. Shea, appointed a board made up of Messrs. Thos. C. Clarke, Alfred P. Boller and Henry G. Prout, all members of the American Society of Civil Engineers. After Mr. Clarke's death, in June, Mr. Samuel Whinery, M. Am. Soc. C. E., was appointed in his place.

The substance of the report is well condensed in the following list of "controlling principles" which have guided the board in its work, and of "recommendations" which it has determined upon.

CONTROLLING PRINCIPLES.

(1) The required capacity of the terminal is measured by the capacity of the bridge itself. Nothing would be gained by enlarging the terminal beyond the capacity of the bridge.

(2) The traffic capacity of the present bridge has been nearly reached, and it cannot be greatly increased without making radical changes in, or rebuilding the structure, which it would not be practicable to undertake until the completion of Bridges Nos. 2 and 3.

(3) No satisfactory permanent relief for the congestion at the terminal of the bridge can be provided or hoped for, except through the completion of the new bridges, now under way; these when opened and properly connected with the downtown district will divert travel from the old bridge, and thus reduce the burden it now carries.

(4) Any general plans for relieving the present conditions should contemplate not only improving and increasing the capacity of the present Manhattan terminal, but should make it possible and practicable to diminish the pressure at the terminal by extending the bridge car and elevated tracks so that a part of the mass of people can be handled at stations other than the bridge terminal.

(5) The greatest measure of utility in serving the public and relieving the present bridge will be secured by connecting it with Bridges Nos. 2 and 3 in such a manner that the bridge trains may operate in both directions in a circulating system embracing the three bridges.

(6) Pending the opening of the new bridges measures should be taken to utilize, as far as possible, the full capacity of the old bridge, and to make such improvements at its terminal as will relieve the congestion and discomfort to the greatest possible extent.

(7) To relieve the congestion at the terminal, dependence must be placed, not so much on increasing its capacity as on diverting from it a part of the travel to other stations, thus virtually converting it from a terminal to a way station. The circulating system of bridge trains having way stations on the connecting roads will be an important factor in accomplishing this purpose.

(8) Since a large part of the crowds that now use and will continue to use the bridge and terminal come from the dense business district south of the bridge, some provision should be made for intercepting and handling a part of this travel before it reaches the present terminal.

(9) In connecting the three bridges and providing other stations for handling a part of the people who now use and will continue to use the present bridge, regard should be had to making suitable connections or transfer points with the north and south transportation lines of Manhattan, to supplying some crosstown facilities in the downtown district, and to a connection with the more important of the North River ferries.

(10) No system of local loops for handling the bridge cars west of the present platform would materially improve or increase the present bridge car service.

(11) The terminal of the trolley car service over the bridge must for the present remain in the Manhattan terminal. The trolley car tracks cannot be extended across Park Row and its existing surface tracks. These tracks are now burdened to their full capacity, and to cross or cut into them would result in serious obstruction to both systems, and would increase the congestion at that point.

(12) The terminal trolley tracks should be so spaced as to provide ample platforms between them; passengers should be prevented from crossing tracks at grade, and incoming and outgoing passengers should be separated.

(13) Any changes at or enlargements of the Manhattan terminal should, so far as possible, be of such a character that they may be carried out without serious interruption to travel.

(14) These changes should be of such a character that substantial benefit may be realized in the shortest possible time.

(15) While the existing conditions at the Manhattan terminal are such as to justify, if necessary, the expenditure of a large sum of money to provide a remedy, economy must not be disregarded, particularly since the question of arranging the finances so that the work may proceed without delay is of the utmost importance.

RECOMMENDATIONS.

Briefly stated, our recommendations are as follows:

(1) That an elevated road be built from the Manhattan terminus of the New York and Brooklyn Bridge along Center St. and Marion St. to Spring St. and thence along Spring and Delancey Sts. to the terminus of Bridge No. 2; and that a branch of this Center St. line be built on Canal St. to the terminus of Bridge No. 3. That the first-named portion be completed by the time Bridge No. 2 shall be completed, and the Canal St. branch be completed by the time Bridge No. 3 shall be opened for travel. That that portion of this elevated road from the bridge terminal along Center St. to Canal St. be constructed with four tracks, the remainder to be double-track road. That the portion of the proposed elevated road from the existing bridge terminal to a point on Center St. north of Worth St. be built at once, and a commodious station be built at Worth St., with sidings and switches north of this section for tail switching and returning trains.

(2) That a double-track elevated road be built as soon as practicable from the Manhattan terminus of the New York and Brooklyn Bridge southward along Park Row and across Broadway to Vesey St.; thence westward along Vesey St., crossing the Sixth and Ninth Ave. elevated roads above grade to West St., and southerly along West St. to the vicinity of the Cortlandt St. ferry on North River. That the terminus on West St. be provided with a suitable station and such extra sidings and switches as will enable trains to be returned to the bridge. That a commodious station be placed on Vesey St., between Church St. and West Broadway, with connections by stairs and platforms to both the Sixth and Ninth Ave. Elevated roads. We regard this Vesey St. line as very important, and it is strongly recommended; but it is independent of the Center St. line, and its omission would not affect the other improvements recommended.

(3) That the present gallery floor (second floor) of the Manhattan terminal building be converted into, and be used exclusively for, a trolley car terminal, the loop tracks to be wide apart and each track to be reached by two separate stairs from the ground floor, one for outgoing and one for incoming passengers.

(4) That a commodious stairway entrance to the terminal be made at Rose St. This will not only accommodate a large number of people in that vicinity, but will tend to reduce the crowd that now enters at Park Row. Plans for these stairs are already completed by the chief engineer and superintendent.

(5) That the present stairway leading from William St. up to the first floor of the terminal be widened materially and made straight, and that a corresponding stairway opening into William St. be built in the north side of the building. The William St. stair is now one of the most crowded places about the terminal, and its capacity is entirely inadequate.

(6) That the trolley tracks and the roadways be separated from each other by curbs placed between them over the whole length of the bridge, thus preventing vehicles from using the trolley tracks.

(7) That some plan for cleaning the roadway of the bridge shall be devised that will not interfere with the free moving of the trolley cars and trains; and that repair work which may interfere with the travel of any kind on the bridge be done during the hours of minimum travel.

(8) Until the Center St. line can be ready for operation to the Worth St. station we recommend that the present system of operating the bridge cars be unchanged. No practicable temporary changes there that we have been able to devise will increase materially the present capacity of the bridge trains.

ESTIMATE OF COST.

While we have not attempted to make a detailed and close estimate of the cost of the work herein recommended, we assume that you will desire to have an approximate estimate of what, in our judgment, it would cost to carry out the extensions, changes and improvements we have recommended, and we submit the same herewith. Our estimate of damages to property along the line of the proposed elevated extensions is predicated on the experience of the Manhattan Elevated R. R., but it is necessarily little more than a rude guess:

Cost of the Center St. elevated extension, complete, including three stations and property damages	$1,773,000
Cost of the Park Row, Vesey St. and West St. elevated extension, including two stations and property damages	722,900
Cost of all changes and additions to the Manhattan terminal	200,000
Cost of curb between trolley tracks and roadway entire length of bridge, and widening roadway at the existing offsets	6,500
Grand total	$2,702,400

The remainder of the report is devoted to a statement of the facts which have led the engineers to the conclusions above set forth. Concerning the proposed Center St. elevated railway, the engineers suggest that it might well constitute a loop system, trains passing over the present bridge in one direction could use these elevated tracks to reach Bridge No. 2 or No. 3, and pass over them in the reverse direction. Thus, a circulating system would be established in both directions, and close connection would be made at several different points with half a dozen main north and south lines of transit on Manhattan Island. The part of the report likely to be most severely criticised (and which, in fact, has already been generally condemned by the newspaper press), is the recommendation of an elevated railway down Park Row and Vesey St. We quote the Board's argument in favor of this in full as follows:

> The elevated double-track road from the bridge terminal through Park Row and Vesey St. to West St., with its terminal in the vicinity of the Cortlandt St. ferry, will be a convenience to passengers between many New Jersey points and Brooklyn, and its station on Vesey St., between Church St. and West Broadway, will provide easy transfer between the Sixth and Ninth Ave. Elevated roads.
>
> Its most important function will, however, be to take up and deliver passengers who now use the terminal station, at the commodious Vesey St. station, thus still further reducing the congestion at the bridge terminal. This Vesey St. station will be nearer to and can be more conveniently reached by many of the people in a dense business district than the present terminal station. This proposed extension will doubtless be used by trains from the Brooklyn roads that cannot well use the circulating system via the new bridges, but a system of transfers at convenient points will make it available for passengers to and from all sections of Brooklyn.
>
> Objections will doubtless be made crossing Broadway with an elevated railroad. Such objections must be purely sentimental, and, while they should not be disregarded, we do not believe that aesthetic considerations should be allowed to stand in the way of commercial exigencies in lower New York. Our plans contemplate, and our estimates provide, for a bridge of sufficient span and elevation to offer no obstruction to travel, so designed as to be as unobjectionable as practicable from an aesthetic standpoint.
>
> As this extension must cross the Sixth Ave. and Ninth Ave. Elevated lines overhead, it may be objected that the great elevation of its station on Vesey St. will prevent people from patronizing it; but the elevation above the street at this point will not be greater than the elevation of the bridge car tracks above Park Row at the bridge terminal, and therefore will not increase the height to be climbed by bridge passengers. Besides, ample room could be had at the Vesey St. station for a system of elevators to transfer passengers from street to station. While the use of elevators for this purpose has not been much developed in this country, they are in constant use for all the new underground roads in London, where they handle a great traffic by lifts twice as high as that required at Vesey St.
>
> The building and use of these connections and extensions

will make unnecessary the tail-switching system at the terminal, and will thus make possible the use of five-car trains, which, being fed from the extensions, can be dispatched at intervals of 45 seconds or less if that shall be found desirable. Furthermore, if it be decided that the strength of the bridge, in its present condition, or as it may be reinforced, is sufficient for longer trains, they can be readily operated.

The room now occupied in the terminal building by the switching tracks will no longer be needed for that purpose, and the passenger platforms can be extended to the full length of the building. There is sufficient space to permit making these platforms each 2 ft. wider. The increased length of these platforms will permit a satisfactory separation into different groups of the travel for the various Brooklyn routes, and will supply the additional platform space that will then be required.

If, for any reason, it shall be thought desirable to have tail-switching facilities near the bridge terminal, as for local trains, the necessary switches and tracks can be provided along either of the elevated extensions outside the building.

The practical effect of these extensions, and the circulating system of trains over the three bridges, will be to convert the present station from a terminal to an important way station, resulting in a great reduction of the number of passengers, which, as a terminal station, it would continue to receive.

The improvement of the trolley car terminal, the Board says, was the most difficult part of the whole problem. The solution finally chosen is admitted to be open to more or less objection; but is believed to be less seriously defective than anything which has been or can be devised. As stated above, the plan proposed is to build on the gallery or mezzanine floor of the bridge terminal, six loop tracks for the use of trolley cars, each track with its adjacent platform space to be fenced off from the others, with separate stairways to each platform for incoming and for outgoing passengers.

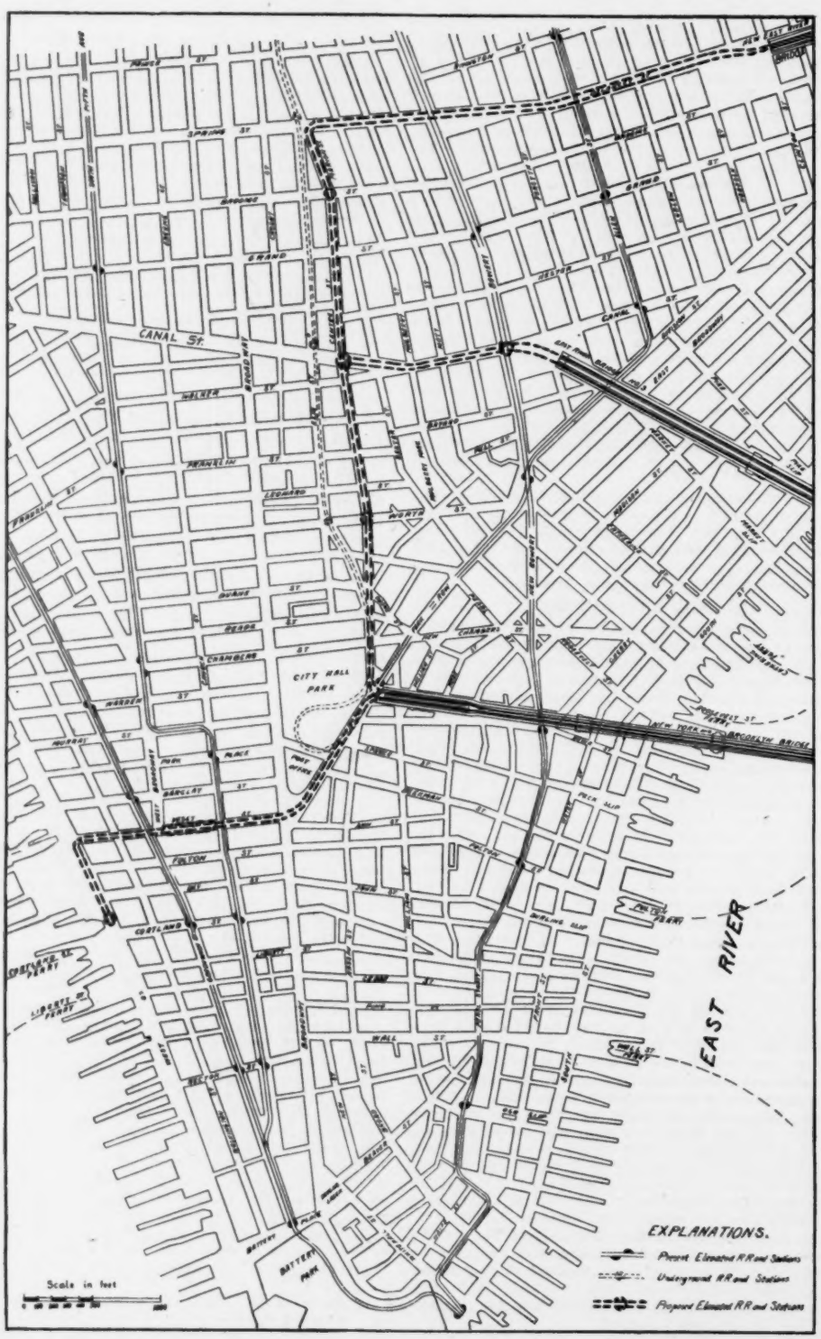
As an alternative plan, it is proposed that the trolley loops remain on the street level as at present, but be moved eastward and spaced further apart. This will be much cheaper and simpler, but would leave the dangerous features of the present trolley terminal substantially unchanged, the only advantage gained being the securing of greater space about the tracks.

One recommendation to which strenuous objection has already been raised is the [illegible] of a curb between the trolley tracks and the vehicle roadways. We give the reasons assigned for this recommendation in full as follows:

> The wagon road is only wide enough to accommodate a single line of vehicles without encroaching on the trolley tracks. The result is that the carriages and lighter vehicles endeavor to pass the trucks and other heavy vehicles, and in doing so they must encroach on the trolley tracks, compelling the cars to check or stop; when one car checks or stops all those behind it must check or stop. As the roadways cannot be widened without reconstructing the bridge, the only way to prevent delays of this character is to strictly confine the carriages and trucks to the single line of travel. While this would to some extent be a hardship upon the faster-moving vehicles, it would not greatly increase the time occupied by them in crossing the bridge, and, inasmuch as the persons using the cars outnumber in the ratio of more than 500 to 1 those using the roadways, it does not seem unreasonable to subordinate the convenience of the smaller to the larger number. The delays to the trolley cars from this cause are great, and if prevented the average speed and regularity of movement of the cars would be materially increased.

In conclusion, the Board shows from traffic statistics, that unless the present concentration of traffic at the bridge terminal can be lessened it will shortly be necessary to handle during rush hours not less than 75,000 passengers per hour in a space not more than 200 ft. square.

We have commented on the report in our editorial columns.



MAP OF LOWER NEW YORK CITY, SHOWING PROPOSED ELEVATED RAILWAYS FROM EAST RIVER BRIDGE TERMINALS, AS RECOMMENDED BY THE BOARD OF EXPERTS.

ANNUAL CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION AT NEW YORK CITY.

The annual convention of the association was held at the Madison Square Garden, New York city, on Oct. 9, 10 and 11, 1901. In conjunction with the convention work there was held an exhibit of street railway appliances and material of exceeding interest, and also a convention of the Street Railway Accountants' Association. In another part of this issue there is given a brief account of the more notable exhibits. The following is a report of the convention proceedings, which occupied only two days of the convention period, the third day being devoted by the association to an examination of the exhibits and to visiting the street railway power plants and other points of engineering interest in and about the city. On Oct. 12 about 200 of the members visited, by special train, the works of the Bethlehem Steel Co., at South Bethlehem, Pa., where they were shown the large forgings for street railway power plants now being made by that company, and were entertained at luncheon.

FIRST DAY'S SESSIONS.

The first session of the convention, on Oct. 9, was opened by an address of welcome by Mr. Randolph Guggenheimer, President of the Municipal Council of New York city. The President of the association, Mr. W. H. Holmes, of Kansas City, Mo., then read his address. A feature of the work of the association which was particularly commended by Mr. Holmes was the labors of the Committee on the Standardizing of Street Railway Equipment. In his judgment, there was no more important work looking to the permanent improvement in street railway conditions now engaging the attention of the association, and he urged its continuation. The report of the secretary and treasurer showed the finances of the association to be in excellent condition. Their condition was as follows:

Cash in bank Oct. 10, 1900	$7,000.75
Receipts from Oct. 10, 1900, to Oct. 1, 1901	7,752.68
Expenditures from Oct. 10, 1900, to Oct. 1, 1901	4,624.68
Cash in bank Oct. 1, 1901	10,128.68

The total membership of the association on Oct. 1, 1901, was 181, of which 23 were new members added during the year. After some further routine business, the convention began the reading and discussion of papers. The first paper read was by Mr. Robert McCulloch, General Manager, Chicago City Ry. Co., and was entitled "Street Railways: A Review of the Past and a Forecast of the Future." The paper was largely of the character of a personal reminiscence and was not discussed. The next paper was entitled "The Relation of Inter-Urban Roads to City Roads," and was read by Mr. Ira A. McCormack, General Manager, Cleveland Electric Railway Co. This paper will be printed in a future issue, with an abstract of the discussion which followed it.

THE BEST FORM OF CAR FOR CITY SERVICE.

By Eugene Chamberlain.*

The paper first directed attention to the obvious expense of either double car equipment; that is, one set of "open" cars for summer use and another set of "closed"

*Superintendent of Equipment, Brooklyn Heights R. R., Brooklyn, N. Y.

cars for winter use, or the alternative plan of transferring the truck and motor equipment from one class of car body to the other class of car body, according to the season. As a remedy the convertible car was suggested. The paper then described a form of convertible car designed by the author and used on the lines of the Brooklyn Heights Ry., as follows:

The car has the following general dimensions: Length over all, 37 ft. ¾ in.; length over corner posts, 28 ft.; platforms, 4 ft. 6⅝ ins.; width over all at drip rail, 8 ft. ½ in.; width over all at sills, 7 ft.; width over all at steps, 7 ft. 4 ins.; height from rail to top of trolley board, 11 ft. 4½ ins.; height from sill to top of trolley board, 8 ft. 11⅝ ins.; wheel base, 18 ft. 11¼ ins.; 20 side window openings, 30¾ ins. × 38¾ ins.; floor clearance, inside, 27 ft. 3⅝ ins. in length; floor clearance, inside, 6 ft. 7 ins. in width; clear width inside at window sills, 7 ft. 1 in.

Window sashes are removable, being held in position by three set screws passing through each side and tapping into bosses cast on metal strips in position on outside face of posts; and a change from closed to open car, by removal of sash, may be effected in about 40 mins. At window openings grooves are cut diagonally from top to bottom on side of posts to take cable curtain fixtures, so that when sashes are removed and curtains are drawn down, they incline outward, forming a satisfactory watershed during storms, and the curtains are also provided with a spring flap at bottom. Inside panels are cut in between side posts for the purpose of giving stiffness to the side of the car and also greater interior clearance. The seats are of the individual revolving type, of either cane, with bent wood frames and backs, or upholstered, as fancy may dictate, resting upon a movable arm carrying the seats in multiple, the arm in turn being pivoted out of center upon a fixed base secured to car floor. This device allows the seats to shift in pairs from a transverse to a longitudinal position, giving in a car of the above dimension an aisle of 22 ins. in width, while seats are in transverse position, and 44 ins. width while seats are in longitudinal position and the car prepared for a standing load. In either position they will positively seat 36 passengers, 34 facing the direction in which the car is moving; under no circumstances can a passenger, of whatever proportions, without discomfort, occupy a space greater than allotted for one seat. The seats having a clearance underneath, giving ample room for the placing away of handbags or parcels that so often obstruct the main aisle of a car, in the case of the usual type of fixed side seat. Electric heaters are ranged along the wall of the car at convenient points, and when the seats are in longitudinal position the heaters are entirely out of way of contact with ladies' dresses. It is proposed to install electric heaters in the arms supporting the chairs as a more desirable location for bringing the heat nearer the center of the car. The electric lighting consists of three center clusters, and five single incandescent lights ranged along each side of car, with a lamp under each platform hood and electric headlights. Maple floor strips, slightly beveled, are used for sanitary reasons and for ease in cleaning floors.

DISCUSSION.—The discussion was opened by Mr. J. O. Biggs, General Manager, Milwaukee Electric Railway & Light Co., Milwaukee, Wis. He agreed with Mr. Chamberlain in the general principle that a car should be developed which would be suitable for both summer and winter service. A car which would meet the conditions in one locality all the year round would not probably meet the different conditions in another locality. His company had adopted some years ago a standard car for service all the year round and was abandoning as fast as they were worn out its open cars. This standard car was a double-truck car, with a 29-ft. body and cross seats, seating 44 persons. The windows were designed to drop into a space below the hand rail, and the doors at the ends were double, opening practically the whole width of the car. In Milwaukee this car had proved eminently satisfactory. Referring to Mr. Chamberlain's car, an obvious disadvantage was that he was able to seat only 36 passengers in a 28-ft. car, as compared with 44 passengers in the cross-seated car used at Milwaukee. He also thought that the possibility of the seats in Mr. Chamberlain's car being changed by the passengers from the longitudinal to the transverse position, or vice versa, would probably cause trouble. Furthermore, he considered that the mechanism introduced into the car seat to render it convertible was an objectionable feature, and would entail a heavy expense for maintenance. The side door was another feature which he considered undesirable.

Mr. C. S. Sergeant, Vice-President, Boston Elevated Ry., thought that probably every street railway manager had been hoping for years to see a car developed that was both a summer car and a winter car. Mr. Chamberlain's car was a very ingenious device, but was it really a box car and also an open car? He had no hesitation in saying that were such cars run in Boston in summer time in connection with the regular open car the latter would carry practically all the passengers. He had always been at a large expense, in order to satisfy his patrons, to have separate equipment for summer and winter service. He had about 70% of his box cars always ready for use, even in summer, and if the weather changed or a shower came up he made it a practice, as far as possible, to substitute the box cars for the open cars. Considered from the business point of view only, he was reasonably certain that the additional passengers secured by providing two sets of cars did not pay for the extra expense entailed, but this was not the whole question with him. The public demanded the two sets of cars, and he was obliged to meet the demand.

Mr. Chamberlain stated in answer to the criticisms made that during the eight months the car described by him had been in operation, and the six months the seats used had been in service, nothing had been spent for repairs. No seat had been changed from the longitudinal to the transverse position, or vice versa, by a passenger.

ALTERNATING AND DIRECT CURRENT TRANSMISSION ON CITY LINES.

By M. S. Hopkins.*

The problem of transmitting power to outlying districts on city lines is one constantly confronting a large number of managers to-day. The steady growth of outlying districts and the increased suburban traffic incidental thereto, requiring larger and heavier cars and increased speed, have severely taxed the direct current distribution. The manager finds his transportation department unable to provide sufficient cars to handle the increased traffic and maintain schedule speed; the cost of transportation large, due to the necessarily slow speed of cars; the loss in transmission enormous, and he must admit his present feeder system entirely inadequate to meet the rapidly growing demands made upon it. In attempting to meet these demands the usual course has been:

(1) To add copper to the feeder system, which has already reached enormous proportions.

(2) To raise the voltage on certain feeders by means of a "booster."

(3) To install storage batteries at end of lines.

(4) In extreme cases, to build an additional power station, located with reference to economy of copper.

(5) To install an alternating current system in the main power station, with rotary substations at convenient points.

The first four plans lack flexibility, and extensions of any magnitude are attended necessarily with a large outlay of copper, burdening the system with heavy fixed charges and large power house expenses.

It is now possible by means of rotary converters, or motor generator sets, to have as many feeding points or substations, changing high tension alternating current to 600-volt direct current, as may be found expedient, and this at a comparatively small outlay and at a minimum charge for power-house expenses. Of course, the number and location of these substations is determined by striking a balance between the cost of operation of the substations, including interest, depreciation, attendance and fixed charges, and the interest, depreciation and fixed charges on the copper investment. In many cases the item of station attendance, otherwise the most serious of all, may be eliminated almost entirely by making the substations a part of the power house, repair shop or ticket office, or even general office.

For long distances, alternating transmission is now almost universally adopted where an entirely new plant is installed. The many weak points which are always present in any new system have been well worked out and remedied, and it would seem that the time has now come for companies using the direct current apparatus at least to make future additions to the plants with alternating current machinery and thereby avail themselves of economies offered by modern invention, still using their direct current system within an economical range and the alternating current for the outlying districts, thus working the two systems in harmony with each other.

The alternating current system, owing to its great flexibility, can very well be operated in connection with the direct current system, and lends itself particularly well to the solution of the problem of transmitting current to outlying districts. The generators can be wound for high potential, so that the cost of copper is comparatively small, and a high efficiency maintained.

Alternating current machinery consisting of generator, step-up and step-down transformers, and rotary converters, as now installed, seem simple in operation, and should require but very little more attention than existing direct current machinery. The generator at the main power station should require even less attention than a direct current unit of the same size, the step-up and step-down transformers requiring practically no attention. The rotary converters may be located at convenient points along the line, and if in the car house or other points where an attendant is necessarily on duty at all times, little or no expense would be required. Starting up in the morning, shutting down at night, keeping the bearings lubricated, and the occasional putting in of a circuit breaker is about all the attendance that would be required.

In installing an alternating current system in connection with an existing direct current system, it would seem wise to use a number of small rotary converters located at load centers over line. These machines can be so designed as to work in parallel with existing direct current feeders, the rotaries caring for the average load, the direct current feeders coming in to help care for sudden fluctuations, and in case of injury to any one unit the direct current system tiding you over the difficulty. The load factor at the station should not materially change from that now existing with direct current, owing to the fact that even if there are violent fluctuations in the amount of power required from any one rotary it is not likely that the maximum demand for power will occur simultaneously on the other rotaries, and if the machine is properly wound and connected in with the existing direct current system, direct current feeders should go far toward equalizing the load between rotaries.

A temporary substation mounted on a flat car, which can be easily moved from point to point, will be found very convenient for the relieving of extreme and unusual loads which frequently occur in most cities during certain seasons of the year. Street railways are required to move enormous crowds in a very short time, frequently at considerable distances from the power station. On account of the heavy and infrequent character of these loads, and the long length of feeder usually encountered, the copper necessary for the handling of this service by simple direct current feed is prohibitive, and the series booster is frequently resorted to. Even with this device the first cost of installation is considerable, and owing to the resistance of ground return, a practical limit to the amount of power and distance to be covered is soon reached. A temporary substation divides the current returning in the track, reduces the drop to one-fourth of that obtained with a straight feeder, and permits much more satisfactory service to be given with less than one-fourth the amount of direct current feeder copper otherwise required. Where the transmission voltage does not exceed 6,600 volts, it is possible to avoid step-down transformers, and thus decrease the weight of apparatus on the car, by using an induction motor generator set, having this induction motor wound direct for high voltage. Besides the reduction in weight, this arrangement possesses a further advantage over the rotary converter, in that the direct current voltage can be regulated by hand over a much wider range, allowing easy and accurate regulation of the load, which is frequently of great importance in putting the set into service where the line drop is very heavy.

In determining the details of a system of this kind, the local conditions existing must be carefully considered; the districts through which transmission lines pass should largely govern the voltage; the center of load and convenience of attendance determining the location of rotaries. From such information as the writer has been able to obtain, the three-phase system seems to be the best adapted for railway work because of its simplicity and economy in copper, as in each wire of the three-phase system two alternating currents, differing in phase, are combined, and the loss is less than when the same power is transmitted by continuous, single phase or two-phase currents. The three-phase circuit requires but three wires, while four are necessary for a two-phase circuit, the same size wire being used in both circuits. The 25 cycles apparatus has many advantages for railway work. The high inductivity effects, troubles encountered in operating machines in parallel, and difficulty in obtaining slow speeds, have caused the higher frequencies to be abandoned for this work.

The paper concluded with a brief description of the intended application of the principles outlined to the street railway lines in the city of Columbus, O.

DISCUSSION.—Mr. Crosby had not noticed whether the distances involved had or had not been stated in the paper. In order that any general rule might be worked out, these should be stated. In a city of the general size of Utica, N. Y., the use of alternating current did not at all seem desirable until the question of suburban roads came up. These roads were in one case 16 miles, in another 12 miles and in another 11 miles from the center of the city. It was then thought better that the alternating current should be used for transmission on those outside lines, in the meantime keeping all the inside business within the direct service. In reply to Mr. Crosby, Mr. Hopkins said that he had planned to locate one rotary two miles from one of the city stations at Columbus, O.

*General Superintendent, Columbus Ry. Co., Columbus, O.

SECOND DAY'S SESSIONS.

The second day's sessions of the convention were opened with the transaction of a number of items of routine business, after which the reading and discussion of the technical papers were resumed.

THE BEST MANNER OF CONDUCTING THE RETURN CIRCUIT TO THE POWER HOUSE.

By E. G. Connette.*

With the great variety of devices and improvement in the art of bonding the rail joints at the present time, there is yet more or less trouble experienced, and the tendency is towards a jointless metallic return by using electrically welded or cast-iron joints, which practically makes an unbroken metallic return, so far as the tracks are concerned; but, unfortunately, a large number of street railroads are not financially able to relay their tracks with heavy rails and use the improved method of joint support and connections, and the problem with them is yet unsolved as to how to bond the joints of the rails so as to get a perfect connection and one that will stand and overcome all resistance or loss. It must be remembered that in a mile of track there will be from 176 to 352 joints, and while the rails of the track have more than ample capacity for conveying the current, the joints must be so connected as to give the current a path across of but little or no resistance; when the joints are properly bonded the track for a period of time answers well for a return circuit, but after a while the connections at the joints become corroded, the bolts are worn, the joints deflect and the bonds here and there are either broken or worn in two, or corroded and loose at the connection, and the result is a very imperfect and inefficient ground return. In some instances there is an insufficient amount of wire used for the return circuit from the tracks to the power house, and in some cases when there is enough wire for this purpose, the connections to the rails are inadequate and creates a resistance that neutralizes the conveying capacity of the copper intended to convey the return circuit to the power house. The wires of the return circuit should be connected to the rails with a connection of equal capacity to the conductor, and should be connected in three or four places, so that if one should become broken or disconnected there would still be ample carrying capacity in the other connections.

It is, therefore, the opinion of the writer that "the best manner and mode of conducting the return circuit to the power house" is by using practically a jointless and independent metallic return, connected to each rail, and the connection made with ample surface contact and absolutely water tight; on account of the chemical action, which is likely to take place between the copper rivet and the steel rail, the rivet should be covered with a thick coating of lead, solder or tin. The best connection which can be used, if the facilities are available, is to electrically weld the connection from the auxiliary ground wire to the center of each rail, and, I dare say, that even with the extra initial cost of an independent ground wire it will result economically in the long run. If an independent metallic return circuit were usual now, there would be no necessity for a paper to be written on this subject; there would be no more need of discussing the subject of rail bonding, or of electrolysis, or of the best method for discovering bad connections in the return circuit, and the expenditure of a large amount of money for expert investigation and advice to cure the bad results of the present imperfect system of conducting the return circuit to the power house; and the amount saved in decreased loss of power, cost of rail bonds and labor of renewals, tests and investigations, as well as the trouble and expense incident to electrolytic action will be more than ample to pay a large interest upon the cost of installing an independent ground return.

Cast-iron joints and electrically welded plates on the joints makes the rails of the track practically a jointless metallic circuit as a conveyance for the electric current, but the very large number of joints in the rails of the track makes the certainty of an unbroken and continuous metallic circuit a doubtful proposition, as the wear and tear of heavy traffic, and the expansion and contraction of the metal, will in the course of time produce results which may very materially impair the efficiency of the joints as a perfect conductor, and it appears to the writer that it is just as essential to have a conductor of as perfect design and as efficient in carrying capacity to convey the current back to the power house as is used to convey the current from the power house to the car, and if this were the case there would be no more troubles with the return circuit. I do not advocate a double trolley, because of the difficulties which are well known to street railway people, but an independent metallic return used

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in connection with the single trolley system is not as expensive to install as the double trolley system, and, practically, obviates all the troubles incident to the ground return, where the rails with bonded joints are used for the return circuit.

DISCUSSION.—Mr. E. P. Roberts, of Cleveland, O., very much doubted whether return wire conductors throughout were commercially desirable. He believed a good return circuit could be obtained without a continuous wire. The matter of cross-bonding was an important one, and one seldom taken into consideration. It costs comparatively nothing as compared with a continuous wire return to cross-bond at the top and bottom of grades, at the ends of curves and at all special work, and the result was quite satisfactory.

Mr. L. E. Myers, of Peoria, Ill., thought that no one was getting perfectly satisfactory results with present methods of providing for the return current. He agreed with Mr. Roberts as to the desirability of frequent cross-bonding. He thought the author of the paper had recommended the best thing to be done, but his experience had been that even in that method there were many defects.

Mr. W. E. Harrington, Vice-President and Manager, Camden & Suburban Ry. Co., Camden, N. J., thought that while it was necessary to provide a return conductor for large roads, especially near the station, this did not seem to be warranted on small roads operating 50 or 100 cars distributed over miles of territory. He had about three years ago begun using a form of rail bond which had so far given satisfaction. This consisted of a cast copper plate 4 × 6 × ⅛ to ⅝ in. clamped to the web of the rails by a cast-iron plate, 4 × 6 × 1 in., with two 1-in. bolts. The copper plate had two grooves, which matched two grooves on the cast-iron clamping plate, and through the passages between the iron and copper plates provided by these grooves two No. 000 copper wires were run. The cost of these bonds had been about $1.50 each. In placing these bonds the surface of the rail was ground, and both it and the adjacent surface of the copper plate were dressed with Edison-Brown alloy. At crossings he bonded from one side to the other with No. 0000 wires enclosed in terra cotta pipes laid under the tracks. He considered that the use of continuous copper returns was uncalled for; it was very expensive and by no means always accomplished the purpose for which it was designed. Regarding electrolysis, he had found that nearly all the trouble experienced by them was attributable to the current leaking into small gas or water pipes crossing underneath the tracks and in close proximity to them. He had overcome this difficulty to a large extent by having these pipes placed in terra cotta conduits.

THE VALUE OF STORAGE BATTERIES AS AUXILIARIES TO POWER PLANTS.

By W. E. Harrington.*

The bulk of this paper was taken up with the description and results of a series of tests made on the writer's lines, which were accompanied by a large number of diagrams, which we do not reproduce. The other parts of the paper which were of the most general interest are given in the following extracts:

The installation of a storage battery in a street railway power station will lead to economical results under the following conditions: (a) When the load is of a very fluctuating character; (b) when the peak of load is of short duration and is either considerably in excess of the average load or perchance in excess of the capacity of the station; (c) when light night loads are to be carried, which permits shutting down the steam plant; and (d) when a station is equipped with a diversity of engines and generators having different characteristics.

The results obtainable from the installation of a storage battery in the power station only affect the economy of the station and in no wise can be considered as an aid to the feeder distribution, except perhaps in maintaining a more uniform voltage at the station. The use of a storage battery in the power station calls for special apparatus, in the shape of boosters, special reversing rheostats and switchboard auxiliaries, not required in storage battery substations located on the feeder lines. With all this, however, conditions may be such as have been outlined and fully warrant battery installations. A storage battery does not in itself generate energy, as the generator does, but under the conditions a, b, c and d may by the economies obtained have the same effect as the installation of additional generating apparatus, with the attendant advantage of more economical operation and lesser capital investment.

In considering depreciation a point usually lost sight of, power station generating apparatus depreciation, should be carefully weighed. There is no question but that the battery materially reduced the rate of depreciation on the machinery in the power station, and may more than pay, by the reduction in the expenditures in repairs and by prolonging the life of the generating apparatus, the expense charged as storage battery depreciation.

An incidental advantage of a storage battery installation is in its lightning arrester capacity, the plates offering through the electrolyte such an excellent path to ground, as well as acting as a large condenser, serves as the best protection against the serious effects of lightning discharges that can be obtained. This effect of lightning protection has been frequently noted; in fact, on the lines where substorage battery stations are located lightning discharges have never been experienced in the Camden & Suburban power stations.

In the study as to the advisability of installing these substorage battery stations, several questions immediately presented themselves: (1) What will be gained; (2) how much will it cost to install; (3) how much will it cost to maintain; (4) where shall it be located; (5) what is the depreciation; (6) what kind of attention is required.

These questions require a careful study of conditions. The writer will take a case occurring in his own experience, and readers can then draw deductions to suit the particular cases in which they may be interested.

The Camden & Suburban Ry. Co., of Camden, N. J., has a line running to a town called Haddonfield, 7½ miles from the power station. Forty-foot double-truck cars, weighing 14 tons each, equipped with two No. 38 B. Westinghouse motors, running on 10-minute headway, gave a fluctuating voltage at Haddonfield varying between 350 to 550 volts, the power station voltage being maintained at 550 volts. Two No. 0000 feeders run from the station to a point six miles from the station called Westmont, and one No. 000 runs through from there to a point about 1,000 ft. from the extreme end of the line. About 2½ years ago careful readings were taken on the feeder, and the fluctuations on this line showed a mean variation of 150 amperes. A calculation showed that the installation of sufficient copper to bring the average pressure not less than 450 volts would require $16,416. We obtained prices upon a storage battery and (ground and a building to accommodate it) to have a discharge rate of 160 amperes, one hour discharge, but having the racks and building to permit of doubling the capacity. The cost of this layout proved to be $9,000, showing a net saving in first outlay of $7,416. Upon this showing the installation was made. This battery consists of 240 cells type 9-F Electric Storage Battery Co. make.

The cost of maintenance to date has not been over $100 per year. The depreciation is covered in a fund carried at 6% on the cost of the battery, amounting to $480 per annum. The attention required is only nominal. The battery is tested by a man sent from the power station once a week to test voltage and specific gravity of each cell. The advantages and saving effected we are confident exceed the apparent expense, in that the line voltage is constant, thus saving in motor depreciation. The saving in interest on the copper we would have had to purchase amounts to $370 per annum. The night car on this line is run from the battery an average of four hours each night, saving in net cost of coal at power station per year at least $60, which, added to the interest saved of $370, makes $430. The more uniform loading at the power station is the principal feature. The engines work with less fluctuation. The economy attendant upon this feature alone, in the writer's judgment, is sufficient to compensate for the apparent expense attendant upon the investment.

DISCUSSION.—The discussion was opened by Mr. N. H. Heft, President Meriden Electric Ry. Co., Meriden, Conn., who stated that his notions respecting the storage battery had been obtained solely from a study of the commercial side of the question. He had eight storage battery stations, and they had been very expensive to maintain. Until the makers of storage batteries could develop a battery of more satisfactory type than those which they are producing at present he would not recommend installing any more storage batteries. In installing his batteries he had been guided, so far as their size was concerned, by the manufacturers. When he had complained to them of the cost of maintenance they had ascribed the trouble to faulty superintendence. He had then had the manufacturers furnish a superintendent, with the result that no better showing had been made than at first. The chief expense was in replacing the plates.

Mr. F. Uhlenhaut, Chief Engineer, Consolidated Traction Co., Pittsburg, Pa., thought that excessive cost of maintenance of storage batteries was often due to the excessive amount of work required of them. Mr. C. W. Mason, Cleveland, Painesville & Eastern Ry., considered that if attention was paid to locating storage battery stations where the building could also be used as a substation or depot for freight much could be saved in the shape of expense for attendants. An important point in favor of the storage battery was its ability to carry the load for a time in case something happened to stop the main generator. In one instance which occurred in his experience the battery was floating on 1,600 K-W., and one of the valves of the engine stuck and threw the engine out of service for 15 minutes, and the battery carried the load without anyone knowing of the change. Mr. Crosby stated that in Washington a storage battery located near the center of the city was able to carry a load of 75 cars for about six hours when, through some accident, the power station had to cease operation. The drain on the battery was large, but it did the work satisfactorily. He wished to suggest that the use of a storage battery on outside lines might enlarge considerably the area over which direct current could be satisfactorily operated.

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REPORT OF COMMITTEE ON STANDARDS.

This committee presented a preliminary report, accompanied by a large number of blue prints of the standards recommended. As these prints are not available at present for publication, mention can be made of only a few of the general features of the report, as follows:

A T-rail was recommended as the "most desirable under any conditions." A car wheel with a plate center and cast-chilled tire was recommended for all speeds up to 50 miles per hour; for greater speeds a steel tire was recommended. Open-hearth steel axles, upset at the point of gear wheel fit 1 in. to allow the cutting of the key seat above the line of wheel fit, were recommended. Journal brasses, brake head and shoes and journal boxes were recommended to conform to the Master Car Builders' standards. For city and suburban service the report recommended a closed car body not to exceed 20 ft. in length, mounted on a single truck; for city service a 25-ft. closed car body, 35 ft. over all, with concave sides, mounted on double trucks; for suburban service from center of population, a 30-ft. straight side closed car body, 40 ft. over all, mounted on double trucks; for "open cars," a 10-bench body, 30 ft. over all, on double trucks, and a 12-bench body, 35 ft. over all, mounted on double trucks. Oval roofs for cars were recommended instead of monitor roofs. No recommendations for electrical equipment were made.

The discussion on this report was brief. The work of the committee was commended, and upon motion the work was ordered to be continued for another year by a committee to be appointed by the Executive Committee of the association.

THE MODERN POWER HOUSE.

By J. H. Vail.*

In introducing his paper, the author stated that he did not propose to discuss the general question of power house design, but rather to call attention to certain processes or appliances which made for economy and which might with advantage be introduced into existing or prospective stations. If we were to secure additional economy, we must look for it outside of the engine. The use of pulverized fuel was one way in which future economy was possible, the use of superheated steam was a second, and the use of cooling towers for condensing water was a third. The advantages urged for each of these apparatus were those which are already made familiar to our readers by previous articles published in our columns, and they will not be rehearsed here.

The discussion of the paper was very brief. It related almost entirely to the use of cooling towers, and turned upon the question, At what price of water does it become more economical to use a cooling tower than to continue the ordinary condensing system? Mr. Vail was not able to answer this question, nor were any of the other members who spoke.

SIGNALS FOR SUBURBAN AND INTERURBAN RAILWAYS.

By William Pestell.†

The paper opened with a general discussion of the growing necessity of operating electric railways by signal, and noted the fact that so far no very satisfactory signal system had been devised for electric railways. The paper then continued as follows:

The telephone is rapidly being introduced along the lines of street railways for this purpose, but the street railway companies are at a disadvantage in the use of the telephone in not having men permanently located at frequent points along the line of the road. Having to depend on the car crews for one end of their dispatcher system, much valuable time is lost in receiving and imparting the necessary information. Another defect of the telephone system for dispatcher work on street railways is the inability to reach car crews at the time required and the likelihood of several crews trying to use the "phone" on different points of the line at the same time. It is not intended to convey the idea that the telephone is not desirable as an aid in operating street railway systems, but that the telephone of itself for general use is not to be wholly relied upon. In connection with a reliable signal system it should be of inestimable value, as the use for dispatcher work would be reduced to a minimum, and with proper rules, intelligently followed, practically all conditions could be provided for, giving the single track road its maximum efficiency and putting it more nearly on the basis of a double track road.

Where the necessity of a signal system on electric roads seems to be generally indicated is on single track roads, both for suburban and interurban service, city service usually requiring special applications to cover local conditions. The object of a signal system for such purpose would be to indicate a safe passing point for cars going in opposite directions, giving single-track roads, with fairly frequent passing points, more nearly the same operating conditions as those of double track roads, and thus avoiding delays and maintaining the schedule.

The experience of steam railroads in the use of signals, their reliability and the confidence now placed in them, makes it reasonable to suppose that equally good apparatus can be developed on the vast mileage of electric railways. Different signals for day and night use (as disks or semaphores by day and different colored lights at night) seem to be thoroughly established for any class of signal work, as regardless of the purpose for which a signal is set it should always be easily discernible.

All signals will add certain elements of danger due to changes of failure inherent in every piece of mechanism. It is therefore important to select a signal with the chances of failure so slight that only the added safety resulting from its use need be considered. The use of block signals on steam roads has reduced the liability of rear-end collisions, and yet were the signals of such construction as to be unreliable the danger would be greater with than without the signals.

In this connection, it would be well to note the care bestowed by steam roads on their signals. They employ trained mechanics, whose duty it is to see that all signals are properly inspected and maintained. An electric road usually puts its signals under the care of a lineman, or some other man who may know but little of either their principle or mechanical construction. It is natural to suppose that as the use of signals increases more care will be bestowed upon their inspection and maintenance. The first and most essential element to be considered in connection with any signal system is that of safety, and no signal should be considered unless its reliability can be demonstrated to such an extent that it adds to the safety of operation of the road.

Among the various types of signals in use we find those depending wholly on incandescent lamps, those depending wholly on semaphores or disks illuminated at night, and those depending on disks or semaphores by day, and upon colored lights at night for their visual indication. Another type of signal is that which leaves the trolley wire dead on the entering side of turnout ahead and leaving side of turnout behind, thus preventing a car from either end of the block entering until block is clear.

Again, we find various devices in use for operating the above types of signals. First, the manually operated switch, which has been in use for perhaps the longest time, and is generally conceded a failure, owing to the fact that the men cannot be relied upon for its proper operation. Second, we have the rail contact devices,

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which have been very little used, and, so far as I can learn, are not generally exploited. Third, we have switches operated automatically by the passing of the trolley, which are coming into more general use as the state of the signal art progresses. These may be divided again into several classes. One in which a contact is simply made by the wheel sliding upon a contact surface normally insulated from the trolley wire. Another, operating a switch mechanism by the passing of the trolley, making various connections, selected according to the direction the trolley passes under the switch. Still another in which the mechanical work of the signal is partly done by the trolley in passing under the switch. Each of these types of signals and switches in service may have a particular value for the location to be protected. It would be unwise at this time to make any recommendation covering general conditions.

DISCUSSION.—The discussion which followed this paper was quite extended, but was of interest chiefly as indicating the interest felt by the various members in the subject of signaling. Nearly every member who spoke admitted the great necessity of some form of signaling system if high-speed suburban and interurban electric railways were to be operated safely. It was the general opinion also that none of the systems now in use was satisfactory. Many members believed that the proper solution of the problem was to adopt steam railway methods.

ELECTION OF OFFICERS.

The following officers were elected to serve the association during the ensuing year: President, H. H. Vreeland, of New York city; First Vice-President, C. W. Wason, of Cleveland, O.; Second Vice-President, E. C. Foster, Boston, Mass.; Third Vice-President, H. M. Sloan, of Chicago, Ill.; Secretary and Treasurer, T. C. Pennington, of Chicago, Ill.

TWO NEW GERMAN BRIDGES WITH TRANSVERSE ARTICULATION AND FREELY SUSPENDED FLOORS.

(With two-page plate.)

Two of the most notable of recent German bridges are those across the Rhine at Worms, and across the Elbe at Harburg. The bridge at Worms is a double-track railway bridge, and that at Harburg is a highway bridge, but the same principle of design has been adopted in both, and so far as we are aware, no structures of similar design are to be found outside Germany. For this last reason we devote considerable space to presenting the salient structural features of these bridges.

THE RAILWAY BRIDGE ACROSS THE RHINE AT WORMS.

One of the most notable railway bridges of large size, which has been constructed in recent years, is the new double-track structure crossing the River Rhine at Worms, Germany. This bridge was completed in 1898, and is fully described in the "Zeitschrift des Verines Deutscher Ingenieure" for Dec. 1, 1900, and "Le Genie Civil" for May 11, 1901; from these journals we extract the following particulars of most general interest.

GENERAL DESCRIPTION.—The bridge consists of three main spans, flanked on one side by a short embankment and masonry arch approach, and on the other side by a double-track steel viaduct approach 602.35 m. (1,975.7 ft.) long. The viaduct approach is a deck structure carried on masonry piers. By making the viaduct a deck structure it was sought to economize in masonry by reducing the height of the piers, and also to emphasize the main spans by making the approach as inconspicuous in elevation as possible. To this same end the height or depth of the viaduct spans was kept as small as possible by making it in the form of two parallel single-track structures. The viaduct thus consists of two parallel single-track viaducts, each carried by a pair of parallel deck trusses, each pair of trusses being structurally independent. Besides enabling the use of a shallower girder or truss than would have been possible with a two-truss, double-track structure, this double viaduct construction had the advantage that a load on one track acted in a plane symmetrical to itself and to the structure which carried it.

The main or river spans, three in number, have the following dimensions: Center span, 116.8 m. (383.1 ft.); side spans, each, 102.2 m. (335.2 ft.); clear height above the water, 12.8 m. (40.98 ft.). In appearance, as will be seen from Fig. 1, these spans are arches carrying a suspended roadway. In reality, however, the arch-like structure is a curved girder, the ends of which are tied together by the structure of the horizontal deck or roadway, so that no thrust is exerted upon the piers. In fact, the ends of each span are carried on roller bearings on the piers. A more notable peculiarity in the construction of these spans is, however, what may be termed the relative independence, in respect to transverse deformations, of the main girders, the roadway platform, and the transverse bracing. The theory upon which this construction is based is as follows: A two-truss, double-track bridge, with a load on one track, is loaded unsymmetrically with respect to its longitudinal axis, and the deflection of one truss is greater than that of the other truss. It results necessarily, therefore, that, if the platform connecting the trusses is rigid transversely, there is a twisting or torsion of the structure which produces a slight inclination of the trusses from the vertical plane. To avoid this abnormal effect the engineers of the Worms bridge have united the main trusses with the roadway platfrom and the transverse bracing by means of flexible connections. A transverse section of the span, as shown by the diagrams Fig. 2, is, therefore, not a rigid rectangle, but is a hinged parallelogram, which adapts itself, without producing abnormal stresses in the trusses, to the unequal deflection of these trusses when unsymmetrically loaded with respect to the longitudinal axis of the bridge. It is plain, however, that if each span were thus hinged throughout its entire length, it would be distorted under the action of a transverse force such, for example, as the wind pressure. To provide against this contingency the engineers introduced a strong rigid transverse bracing between the trusses at the extremities of the span where, the amount of deflection being small, such a rigid bracing would not have the same inconveniences as toward the center of the span. Complete independence is maintained between the platform framework and the tie rods between the panel points 1 and 1, Fig. 2a, except that at the center of the span (panel point 8), the two are rigidly joined by riveted connections so that the longitudinal thrust on the platform due to train braking may be conveyed to the main structure. At panel points 1 and 1, expansion joints are provided. Between panel points 0 and 1, at each end, the roadway platform forms an integral part of the structure to which it is attached by riveted connections.

SUPERSTRUCTURE OF MAIN SPANS.—As already stated, each span consists of a curved braced girder whose ends are connected by tie rods or tension members. The braced girder consists of an upper and lower chord connected by verticals and diagonals, as shown by Fig. 2a. The tie rods are of H-section, and connect the feet of the two verticals at panel points 1 and 1. The end verticals below the platform level are connected by a transverse bracing rigidly attached to the verticals, as shown in diagram by Fig. 2d, and in detail by Fig. 3. The upper lateral bracing is shown in plan by Fig. 2b; the various members, as shown by Fig. 3, are designed to resist both tension and compression, but they connect with the main girder chords by means of a thin, flexible steel plate placed horizontally. To keep the members from sagging they are supported by a curved bracket-like brace of channel section, as shown by Fig. 3. Fig. 4 shows this construction more completely, and also illustrates the inspection footways along the plane of the lower chord of the braced girder and the suspended car for the same purpose, which runs beneath the roadway platform. The lower lateral bracing is a double diagonal system connecting the two tie rods. The main floor beams are pin-connected to suspenders extending downward from each vertical, as is shown by Fig. 3. To support the tie rods and at the same time render them independent of the roadway platform, they are hung at each panel point or floor beam by means of a flexible stirrup connection, shown by Fig. 3 and in detail by Fig. 5. Means are provided to preserve the fixity of the platform transversely of the bridge. Fig. 3 shows clearly the arrangement and construction of the roadway, railway tracks and sidewalks. Fig. 6 shows the rigid connection of the platform and the center of the span, or at panel point 8, Fig. 2a.

The supports of each span on the piers are so designed that the span has freedom of movement in three directions: first, an angular movement resulting from elongations of the curved girder; second, rectilinear longitudinal movement; and third, rectilinear transverse movement. The several forms of supports are shown by Figs. 7 to 9. At the fixed end one support is fixed to the pier and is provided with a ball and socket pivot allowing horizontal swing, Fig. 7, and the other has a ball and socket pedestal mounted on rollers, permitting transverse movement (Fig. 8). At the movable end one support has a ball and socket pedestal mounted on rollers permitting longitudinal movement, and the other has a ball and socket pedestal mounted on two sets of rollers (Fig. 9), one set of which permits longitudinal movement and the other set permitting transverse movement.

ERECTION.—The main river spans were erected by means of falseworks, leaving one span free always for the accommodation of navigation. The approach viaduct was erected one-half at a time by means of falseworks, and the traveler shown by Fig. 10.

SUBSTRUCTURE.—The bridge piers consist of a concrete heart or backing faced with stone masonry. Compressed air was employed to sink the foundations for the two river piers which were carried down to a depth of 22 ft. below the river bed. The abutments and shore piers were founded on a concrete footing constructed by means of cofferdams.

WEIGHT AND COST.—Commencing at the left bank the bridge has a total length of about one-half mile, divided as follows:

Description.	Length in ft.	Weight in tons
One side river span	335	858
One center river span	383	1,059
One side river span	335	858
Seventeen approach spans	1,921	2,655
Totals	2,973	5,430

The construction of the bridge, which was completed in December, 1900, occupied 2½ years, and its total cost complete was about $800,000. The bridge was designed and built by the Harkort Works, of Duisburg.

STREET BRIDGE OVER THE ELBE AT HARBURG, GERMANY.

The bridge across the Elbe at Harburg, Germany, is a highway structure, designed upon the same governing principle as the railway bridge at Worms, but it has the corresponding details worked out somewhat differently. The following description of this structure is based upon an article by G. Marten and Prof. S Muller, in "Zeitschrift fur Bauwesen."

The Harburg Bridge consists of four main spans flanked on one side by a steel viaduct approach. Its total length is 598.55 m. (1,963.24 ft.), divided as shown by Fig. 11 into four main spans and six approach spans. The four main river spans are each 100.96 m. (330.14 ft.) in the clear. Transversely the bridge is divided into a roadway between the girders 7 m. (23 ft.) wide and two sidewalks, outside of the girders, each 1½ m. (5 ft.) wide. The bridge crosses the south branch of the Elbe River, which divides just above Harburg, at the so-called Bunthaus, into two branches known as the North Elbe and the South Elbe. Fig. 12 is a view of the completed structure, showing the architectural portal. Aside from the architectural appearance, the chief interest of the bridge to engineers centers about the design of the superstructure of the main spans.

Referring to Fig. 11, it will be seen that each main span consists of two arched braced girders connected by horizontal tie rods. The floor platform is suspended from the arched girders by suspenders at each panel point. This platform consists of transverse plate girder floor beams connected by longitudinal stringers, as indicated by the cross-section, Fig. 13. The connections between the floor beams and the suspenders are flexible at all except the end panel points, where they are rigidly connected to the end posts. To prevent any movement of the girders in the direction of their length they carry at each panel point a vertical pin, which sits in a socket in a casting held by the tie rod. Several of the drawings in Fig. 13 show this detail. The tie rods themselves are braced together by a double diagonal system, to which the floor platform is connected at only one point at the center of the span. These diagonal members are connected to the tie rods with horizontal plates. A similar connection exists between the top chord member in the

arched girder and the lateral system in its plane, at all panel points except the endmost, where rigid connections, in connection with the rigid floor-beam connections at the same points, constitute, with the end posts, a rigid transverse frame to convey the wind pressures to the substructure. It will be observed that the construction described is the same in principle as that of the Worms Bridge. The differences in details are clearly seen by comparing the drawings of Fig. 13 with those of Figs. 4, 5 and 6. The total cost of the Harburg Bridge was about $428,000.

ANNUAL CONVENTION OF THE CENTRAL STATES WATER-WORKS ASSOCIATION.

The fifth annual convention of the association was held at Evansville, Ind., Oct. 1 to 3. The mornings were devoted to business and the afternoons and evenings to excursions and other forms of amusement, which were liberally provided by the local committee. One of the features of the convention was a visit to the new water-works plant, including the pump pit, some 65 ft. deep, in which are two 14,000,000-gallon Holly vertical triple-expansion pumping engines.

After the usual opening exercises the reports of the secretary and treasurer were read. They showed a balance of about $120.

PAPERS ON ELECTROLYSIS.

There were two papers on this subject. The first one, by Mr. Edwin P. Matthews, City Solicitor of Dayton, O., was a lucid and entertaining popular exposition of the whole subject, from both the engineering and legal viewpoints. The author's knowledge of the subject had been gained in attempting to protect the legal interests of the city of Dayton in its struggle against electrolysis. The case against the street railway companies is thus put by Mr. Matthews:

The return circuit of the average electric road would not be nearly as good as it is if it were not for the pipes. This means that the railroad companies are making use of the investments of municipalities and companies having underground pipes, to facilitate the operation of their roads, saving to themselves an investment in the return circuit. This is a great advantage to the roads, for where the return circuit is good, it takes less power and therefore less fuel to send the current out and to operate the road. . . . .

If the pipes could be used for the return circuit without damaging them, we might not complain, but it would still be a trespass while present methods prevail, for I don't recall an instance where a street railroad company has requested permission to use the pipes, or proposed to pay for such use. . . . .

The city of Dayton owns its own water plant, and has begun legal proceedings to obtain redress and to put an end to the menace to its property. Suits have been instituted against the street railroad companies both to recover damages for injury already done the pipes and to obtain decrees compelling the companies to inaugurate systems of traction which will prevent injuries to the pipes from electrolytic action. We think we shall succeed in both classes of cases.

The law authorizes the use of the streets and public ways for water and gas pipes as well as for street railroads. Municipalities and companies owning gas and water-works, and street railroad companies can so conduct their respective businesses and operations as not to interfere with each other, and we believe the law will force them so to do. If water pipes were permitted to leak so that the roadbed of a street railroad was being ruined, and against which damage the street railway company could not protect itself, surely the law would make the municipality or company owning the pipes remedy the evil. Likewise, it occurs to me, that as cities and companies cannot protect their gas and water pipes from electrolysis caused by street railroad companies, which companies can so operate their roads as to avoid the damage by adopting well-known systems and devices, which it is reasonable to ask them to adopt, that the law will compel them to do so and will hold them responsible for damages arising from wantonly discharging electricity into the earth, regardless of the rights of others.

The second paper on electrolysis was by Mr. L. C. Anderson, an electrical engineer of Franklin, O. After describing the nature of electrolysis, the author reviewed the various methods proposed for its prevention. None of these are effective, he urged, if they allow any current to return to the power house by means of the earth as a conductor. The latter part of his paper was a review of an injunction suit brought by the village of Franklin, O., against a street railway company, as follows:

The Southern Ohio Traction Co. operates a single trolley electric line from Dayton, O., to College Hill, a suburb of Cincinnati, and uses four power houses, one of which is located in Franklin, O. The road was put in operation through Franklin July 1, 1897. Within a few months after that time service pipes belonging to the village water-works system, and located in the streets along which the electric railroad runs, began to burst from the electrolytic action of the return currents of the railroad. From the beginning of the operation of the road until Aug. 22, 1900, out of 137 service pipes located in these streets, 35 had to be replaced once, 7 twice, and 1 three times. Electrical examinations were made in 1898, 1899 and 1900 on the water system, all of which showed the electrical conditions to be quite serious. In July, 1900, an examination of the cast-iron mains located in these streets was made by excavating and exposing the pipe for a length of about 10 ft. every 500 ft. This examination of the mains showed that they had almost entirely lost their tar coating, and that they were corroded and pitted at each of the stations, some of the pits on the pipes in front of the railroad company's power house extending into the pipe for a distance of at least three-fourths of the thickness of the shell of the pipe.

As a result of these examinations, both electrical and physical, and the continuing loss of the service pipes, an action for $10,000 damages was brought against the railroad company and heard last March in the Warren County Common Pleas Court. When the case got to the jury, they decided unanimously that the allegations of damage, and the cause of the damage had been proven, but failed to agree to a verdict and were discharged by the court. The cause of the failure to agree was learned to be that part of the court's charge pertaining to contributory negligence, the court having charged them as follows:

"The village had the right under law and under said ordinance (the ordinance granting the franchise) to prescribe the manner in which said road should be constructed and operated, and so far as it did by its council prescribe how these things shall be done, it is estopped from claiming damages from defendant for any injury which resulted from defendant or its predecessor carrying out the terms prescribed, or constructing the road in the manner prescribed by the village council" . . . . "As the law casts upon the council of the village the duty of prescribing the manner of constructing said road, it is to be presumed in the absence of any evidence to the contrary, that they discharged this duty, and that the road was constructed, operated and maintained in the manner directed by them." . . . "If it should appear that the road was so constructed with the knowledge and consent of plaintiff, and that a knowledge of the dangerous agency about to be used was equally accessible to plaintiff and the railroad company, and the council of the village at the time of the construction knew that the company was about to adopt the method which it did adopt, and permitted it to do so, and acquiesced therein, it could not be permitted to recover damages resulting therefrom. It might be otherwise, however, if the means of information on this subject possessed by the construction company was much superior to that possessed by plaintiff. In such case the real inquiry would be whether such ignorance on the part of the plaintiff's counsel was itself negligence.

"Should they in the exercise of ordinary care, under all the circumstances, have known the probable injurious results of the machinery about to be put in operation?

"Municipal corporations, like private individuals, are held to the exercise of reasonable care in protecting their own property from injury, and are not permitted to recover for injuries caused by the wrongful acts of others, which they have either brought about themselves or contributed to bring about."

If the view of this court is the correct one, it would seem that too much care cannot be exercised by municipal authorities at the time of granting franchises for electric street railways, if they would properly protect any underground metallic structure belonging to the municipality. And in cases where franchises have already been granted, the proper action should be promptly taken if the continuance of the damage is to be prevented.

In conclusion, electrolysis to underground metallic structures from the return currents of single trolley electric railroads is no longer merely a theory, but a well-established fact. The results are cumulative. The remedy must be of such a nature as to prevent current leaving any part or parts of the underground metallic structures to pass into the surrounding earth. And while the matter is still comparatively new in the courts, there is good reason to believe that the law when properly applied will not be unfavorable in preventing a continuance of the evil.

During the discussion on these two papers it was stated that the report of the committee on electrolysis, of which Mr. F. A. W. Davis, of Indianapolis, is chairman, has been completed and will be included in the published proceedings of the convention. The committee was continued for another year. The convention voted to print, in its report, a review of litigation to prevent electrolysis and secure damages therefor.

THE DRIVEN WELL WATER SUPPLY OF DAYTON, O.

By Chas. E. Rowe.*

The water supply of the city of Dayton, O., is pumped from driven wells, designed to intercept the underflow through the glacial drift of the Miami, Stillwater and Mad River valleys, which rivers unite within the city limits to form the great Miami River. Where these rivers enter the city the valley is about two miles wide. The pumping station is located on Mad River, near the Great Miami, about midway in the width of the valley. Until the past two or three years all the water supplied to the city (population in 1900, 85,333) flowed from the wells by natural pressure. The material pierced by the wells is 15 ft. of loam, mixed with clay and gravel, then loose, clean, polished gravel and sharp sand. The wells are from 25 to 80 ft. deep, "so that the water can be drawn from different levels." The wells extend along the course of the river for a distance of 3,800 ft., and to the levees on either side. The well system was thus described by Mr. Rowe:

All new wells are of 8-in. galvanized iron pipe, with a Cook brass strainer 8 to 10 ft. long at the bottom. Each well is cut off at the proper elevation with the suction pipe, and a T casting fitted on the top. The top branch of the T is threaded for taking the plugs and a 9-in. wrought-iron pipe casing, both of which extend to the surface of the ground. By this means a well may be gotten into without excavating. The horizontal branch of the T leads to the suction pipe. Before reaching the suction pipe, a valve is set in the branch in order to shut off each well independently.

The suction mains necessary to carry the water from the wells to the pumping station are as follows: In the rear of the pumping station is a 66-in. suction main, or header, 300 ft. long, extending from near Ottawa St. to the north side of the river; a 30-in. pipe some 612 ft. long leads down to the river, at the end of which it reduces to 48 ft. of 24-in. pipe and 48 ft. of 20-in. On this main are 22 wells, eight of which are new ones, placed there last season. These 22 wells, under test in the dry season, gave a rate of 7,500,000 gallons of water in 24 hours.

The other branch is a 60-in. pipe going up the river 1,900 ft., and having 56 wells connected to it. At the end of this 60-in. pipe there will be a 30-in. "Y" branch leading to the left or north and having 15 wells connected to it. The end of this 60-in. pipe will be plugged, so that at some later day, should more water be required, it may be extended without crippling the system. These 71 wells are figured to give 28,500,000 gallons of water in 24 hours, which will make a grand total of 36,000,000 gallons in 24 hours from the 93 8-in. wells.

Twelve hundred feet from where the 60-in. main branches off from the 66-in. pipe, there is a 30-in. "Y." From this "Y" a 30-in. suction main is carried back to the pump house on the south side of the river. This 30-in. suction has no wells connected to it at present, and will be used for carrying the water to the station in lieu of the 66-in. should it become necessary to make any repairs in the line. The suction lines leading up and down the river from the 66-in. suction header have a fall of 1 in. to 100 ft. either way from it; and the well connections are laid to a grade of 6 ins. in 100 ft. This is done in order to avoid air pockets forming in the pipes, which would obstruct the flow, and to allow the air to arise readily and easily to the vacuum pumps in the station, where it is removed, which prevents it from entering the large pumping engines.

Although the 5-ft. suction pipe running up the river weighed about 1,000 lbs. per lin. ft., the engineering and laying was so carefully carried out that the water from the wells near the suction header flowed to the extreme east end of this main without leaving any pockets of water in the pipe to exceed ½-in.

Inasmuch as Dayton is probably the largest city in the United States obtaining its supply by means of the tube-well system, frequent inquiries are made of us as to our method of cleaning the wells from sand. We do this in the following manner: First, water is forced into the well by a steam fire engine, which thoroughly loosens all the material adjacent to the well; then a horizontal centrifugal pump is directly connected and the well given a heavy pumping. During this pumping, the column of water is dropped at intervals to keep all loose particles of sand in agitation. After a length of time the water becomes clear and free from all sand.

By actual test, a well that gave only 442 gallons per min. at the start, delivered 463 gallons per min. at the end of 12 hours' continual pumping. We measured the discharge of each well by means of a weir box, and hence have records for each well.

*Secretary Water-Works Trustees, Dayton, O.

LIFTING WATER WITH COMPRESSED AIR AT TIPTON, IND.

By John Langan.*

The city of Tipton takes its water supply from ten wells, 55 to 500 ft. in depth. Two of the wells are 4 ins., six are 6 ins. and two are 8 ins. in diameter. Water was found at depths of 55 and at 106 to 110 ft., which, when tapped, rose to within 7 or 8 ft. of the surface. The wells, when connected to two pumps, yielded only 180,000 gallons of water a day. Early in 1900 Mr. Langan was authorized to develop more water. He communicated with the Ingersoll-Sergeant Drill Co., of New York, and arranged for a test of the wells. The test and subsequent developments are described as follows:

The compressor was connected to two wells, one 6-in. well and one 8-in., and started May 1, 1900. The first test showed the 6-in. well to be yielding 40 gallons per min., and the 8-in. well 70 gallons per min. After working the wells for 24 hours and making some minor changes in the air lines, the 6-in. well yielded 60 gallons and the 8-in. well 90 gallons per min., and on the fourth day the 6-in. well produced 75 gallons per min., and the 8-in. well 130 gallons per min. Other wells were tested with results proportionately to the first, and at the end of 30 days' test, the results were so satisfactory that I was instructed to purchase a compressor suitable for our service.

A class G duplex compressor, 10 × 12¼ × 12 ins., was purchased and installed the first week in December, 1900. The service rendered is very gratifying. We have had no trouble in supplying all demands that have been made on the plant, working the air lift on two wells with what assistance was given by the suction pumps. At any time in the future other wells can be connected up with the air with very little expense, and add very materially to the supply; for the test has already been made and the results are known.

The compressor is run at 32 revs. per min., carrying 33 lbs. air working pressure on a lift of 40 ft.

The Tipton plant is in the center of a group of water-works plants, that are successfully operating the air-lift system, Alexandria and Elwood on the east, Noblesville and Indianapolis on the south, Frankfort on the west, Peru and Marion on the north, and Bluffton on the northwest.

*Superintendent of Water-Works, Tipton, Ind.

OTHER PAPERS AND GENERAL BUSINESS.

Mr. C. W. Wiles, Superintendent of Water-Works at Delaware, O., read a paper on "Hot-Water Heating from a Central Station." Most of the paper was devoted to a description of the methods and advantages of central hot-water heating. The Delaware Electric Light, Heat & Power Co., of Delaware, O., has operated a hot-water plant for four years. Included among its patrons is the Ohio Wesleyan University. Since the plant was put in operation the temperature has been as low as 29° F., but satisfactory results were obtained. Last year the Gwynn Central Station Heating Co. extended the system just mentioned a distance of more than two miles. Among the 95 patrons on the extension are the city hall, a hotel, the courthouse and county jail. The extension was in use and gave satisfaction during the past winter.

Mr. Cleophas Monjeau, of Middletown, O., contributed a paper on "Pure, Wholesome Water, How Obtained." A paper on "The Causes of Tastes and Odors in City Waters" was submitted by Mr. S. J. Hoggson, of New Haven, Conn.

Mr. Jos. J. Pater, of Hamilton, O., was elected president for the ensuing year. Mr. Wm. A. Veach, of Newark, O., and Mr. Chas. E. Rowe, of Dayton, O., were re-elected secretary and treasurer, respectively. The next convention will be held at Indianapolis, Ind., in 1902.